PROCEEDINGS

EPA SCIENCE FORUM 2006:
Your Health, Your Environment, Your Future

May 16-18, 2006

United States Environmental Protection Agency
Ronald Reagan Building and International Trade Center
Washington, DC

Contents

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Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
BOSC	Board of Scientific Counselors
CAA	Clean Air Act
CASAC	Clean Air Scientific Advisory Committee
CDC	Centers for Disease Control and Prevention
CFC	chlorofluorocarbon
CO_2	carbon dioxide
DNA	deoxyribonucleic acid
EPA	Environmental Protection Agency
EST	expressed sequence tag
FQPA	Food Quality Protection Act
NCEA	National Center for Environmental Assessment
NCEH	National Center for Environmental Health
NIEHS	National Institute of Environmental Health Sciences
NRC	National Research Council
OCHPEE	Office of Children's Health Protection and Environmental Education
ORD	Office of Research and Development
PM	particulate matter
STAR	Science To Achieve Results
VOC	volatile organic compound
WHO	World Health Organization

Executive Summary

The Environmental Protection Agency (EPA), in cooperation with the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Disease Registry (ATSDR), and the National Institute of Environmental Health Sciences (NIEHS), presented the *2006 Science Forum: Your Health, Your Environment, Your Future* on Tuesday, May 16, through Thursday, May 18, 2006, in Washington, DC. This *Science Forum* highlighted key areas of relationships between the environment and public health, and showcased scientific research, new initiatives, and recent successes as well as collaboration between federal, state, local, and international public health agencies. The *Science Forum* also provided an opportunity for dialogue and interaction among EPA and scientists, clients, stakeholders, and colleagues with over 1,000 attendees at this event, including EPA program, research, and regional staff; members of other federal and international agencies; the scientific community; and the public.

The *Science Forum* consisted of an opening plenary session, three topical plenary sessions, and a session with former EPA Assistant Administrators for the Office of Research and Development. Each topical plenary session examined a theme area for human health and the environment: disease susceptibility, global challenges, and the built environment. The *Science Forum* included over 227 posters on current research activities and speaker-specific topics, poster-platform sessions, scientists/engineers present to discuss their research efforts, and 22 exhibits of scientific and educational programs at EPA and other federal agencies. The *Science Forum* also included special program sessions on innovation in risk assessment; a panel discussion by the EPA Emerging Leaders Network, and a training session on Cooperative Research and Development Agreements.

Opening Plenary Session

The purpose of this session was to set the stage for exploring *Your Health, Your Environment, Your Future*; exploring the role of EPA as an environmental public health organization; and highlighting the cooperative relationships among U.S. environmental health agencies. Assistant Administrator of the EPA Office of Research and Development (ORD), Dr. George Gray, discussed the themes of the *Science Forum*, the relationship between the environment and health, and national and global environmental public health challenges being addressed through science and interagency cooperation. Dean of the College of Engineering, Architecture, and Computer Sciences at Howard University, Dr. James H. Johnson, discussed the role of science in policymaking for environmental public health. EPA Deputy Administrator, Marcus C. Peacock, discussed EPA contributions and interagency collaborations over the past 35 years, and presented the first 21st Century Visionary Science Leadership Award to Dr. J. Craig Venter. The founder and president of the J. Craig Venter Institute, Dr. J. Craig Venter, discussed his new findings and insights in the most important area of research in the 21st century in his presentation "Secrets of the Human Genome."

Disease Susceptibility Plenary Session

This plenary session, led by Dr. Julian Preston (with EPA) and Dr. William Suk (with NIEHS), examined the relationship between disease susceptibility and the environment and efforts to understand why some of us succumb to illness while others remain well. A key theme is understanding the complexity and linkages of multiple factors affecting disease susceptibility, including genetics, life stage, environmental stressors, and health disparities.

Dr. Steven Kleeberger, with NIEHS, discussed innovative work related to the genome and human disease susceptibility and the relevance of this new science to public health risk assessment. Dr. Elaine Faustman, with the University of Washington, introduced the concept of life-stage susceptibility and research underway to understand this linkage with disease susceptibility throughout life. Dr. William H. Sanders, with the EPA Office of Children's Health Protection and Environmental Education, discussed health disparities among racial, ethnic, and socio-economic groups and the role of environment in health, morbidity, and mortality in these groups.

Global Challenges Plenary Session

This plenary session, led by Dr. Anne Grambsch (with EPA) and Dr. Chris Portier (with NIEHS), examined how a changing global environment (natural and man-made) is giving rise to potential new public health risks and actions that can be taken to ameliorate these risks. A key theme is understanding the global relationships between environment and health and how collaboration in research, education, and regulation can reduce disease and health risks.

Dr. Rita Colwell, with the University of Maryland and Johns Hopkins University, identified new public health challenges arising from changes in global stressors and highlighted examples of new diagnostic methods and new prevention methods to address these challenges. Dr. Howard Frumkin, with the CDC National Center for Environmental Health (NCEH) and ATSDR, discussed the changes in environmental health risks in response to changes in human behavior, global transportation patterns, and extreme weather events. Dr. Peter Preuss, with the EPA National Center for Environmental Assessment, provided an overview of changes occurring in paradigms for risk assessment and the relationship between the assessment of ecosystem, human-derived changes, and human well-being. Dr. Michael Shapiro, with the EPA Office of Water, discussed how federal health agencies in the United States have worked together to reduce health risks related to air and water pollution and the role of similar interactions at the international level in achieving similar results.

Former EPA Assistant Administrators for Research and Development: Current and Future Science Challenges Facing EPA

This session, held in recognition of EPA's 35th Anniversary Celebration, provided an opportunity for the current and five former ORD Assistant Administrators to discuss the past, current, and future science challenges facing EPA. A key theme is the responsiveness of the research program to the changing needs of the Agency, the achievements possible from sound science underlying regulatory actions and other EPA mission elements, and the need to find the appropriate niche for EPA research to address upcoming challenges in the areas of nanotechnology, global warming, and genomic technology.

Dr. George Gray, the current ORD Assistant Administrator, led this session. Former ORD Assistant Administrators providing remarks and participating in the discussions were Dr. Paul Gilman, Dr. Norene Noone, Dr. Robert Hugget, Mr. Eric Brethower, and Dr. Bernard Goldstein.

The Built Environment Plenary Session

This plenary session, led by Dr. Hal Zenick (with EPA) and Dr. Howard Frumkin (with NCEH and ATSDR), explored demographic trends, their impact on health, and how thoughtful planning of the built environment can mitigate or eliminate future environmental health problems.

Tim Torma, with the EPA Office of Business and Community Innovation, discussed the EPA Smart Growth effort to incorporate considerations of environmental health in land use, transportation, and critical services planning; obstacles to smart growth encountered by communities; and benefits of these planning efforts. Howard Frumkin, with NCEH and ATSDR, discussed the relationship between human health and the built environment, the need for healthy places, and trends in population demographics that may impact the built environment and human health in the future. Martin Moeller, with the National Building Museum, discussed principles of sustainable building design as illustrated by the Green House exhibit and green building design from around the world.

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Section I: Overview

The Environmental Protection Agency (EPA) presented a *Science Forum* at the Ronald Reagan Building and International Trade Center in Washington, DC, on Tuesday, May 16, through Thursday, May 18, 2006. The *EPA 2006 Science Forum: Your Health*, *Your Environment*, *Your Future* was an opportunity to showcase the activities of EPA and other organizations in key areas of environmental research and to spotlight new initiatives and recent successes. As the fifth in a series of annual events, this *Science Forum* built upon the first four Agency-wide *Science Forums* held in May 2002, May 2003, June 2004, and May 2005, and was held in cooperation with the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Disease Registry (ATSDR), and the National Institute of Environmental Health Sciences (NIEHS). Appendix A provides the agenda for the meeting.

The *Science Forum* highlighted selected high priority topics and EPA's scientific accomplishments, showcased EPA's commitment to quality science, and demonstrated, through examples, how science influences Agency decisions. The *Science Forum* also provided an opportunity for dialogue and interaction among EPA scientists, partners, clients, stakeholders, and colleagues with over 1,000 attendees at this event. Attendees included EPA program, research, and regional staff; members of other federal and international agencies; stakeholders; the scientific community; and interested members of the public. The *Science Forum* included 227 posters addressing current research activities and specific topics addressed by speakers, poster-platform sessions, and discussions of research efforts by EPA and external scientists and engineers, as well as 22 exhibits of scientific and educational programs at EPA and other federal agencies.

Assistant Administrator of the EPA Office of Research and Development (ORD), Dr. George Gray, opened the plenary session of the *Science Forum* and discussed the theme of the *Science Forum* to inform, educate, and empower the audience to play an active role in the science and research that affects the world in which we live. Other plenary speakers discussed the role of science in environmental health policy, EPA accomplishments in environmental health over the past 35 years, and the linkage between genomes, the environment, and health.

Three topical plenary sessions each examined a theme area for human health and the environment—disease susceptibility, global challenges, and the built environment. The audience had an opportunity in each session to ask questions of the speakers. Poster-platform sessions followed the plenary sessions addressing session-specific and related topics; posters were presented by their primary investigators, followed by open group discussions. Abstracts of the posters are available at http://epa.gov/scienceforum.

The *Science Forum* also included a discussion session with former ORD Assistant Administrators in recognition of EPA's 35th anniversary celebration. This session provided an opportunity for five former ORD Assistant Administrators and Dr. George Gray, the current ORD Assistant Administrator, to discuss current and future science challenges facing EPA.

Special program sessions included a session on innovations in risk assessment practice; a panel discussion on sustainability, stewardship, and collaborative programs by the EPA Emerging Leaders Network; and a training session on Cooperative Research and Development Agreements.

Section II: Plenary Session

Tuesday, May 16, 2006

The purpose of this session on the first day of the meeting was to set the stage for exploring *Your Health, Your Environment, Your Future*; exploring the role of EPA as an environmental public health organization; and highlighting the cooperative relationships among U.S. environmental health agencies. The plenary session also included the presentation of the first 21st Century Visionary Science Leadership Award.

Director of the EPA National Center for Environmental Assessment (NCEA), Dr. Peter Preuss, opened the plenary session. Assistant Administrator of ORD, Dr. George Gray, discussed the themes of the 2006 EPA *Science Forum*, including the relationship between our environment and health as well as national and global environmental public health challenges being addressed through science and interagency cooperation. Dean of the College of Engineering, Architecture, and Computer Sciences at Howard University, Dr. James H. Johnson, discussed the role of science in environmental policymaking and a methodology to integrate scientific understanding with decisionmaking for informed choices and better understanding of long-term consequences of policy choices. EPA Deputy Administrator, Marcus C. Peacock, discussed EPA accomplishments in the area of environmental public health, and presented the 21st Century Visionary Science Leadership Award. Founder and president of the J. Craig Venter Institute, Dr. J. Craig Venter, discussed the challenges in sequencing the genome of various species, how different environments have allowed for evolutionary differences in genetic code, and efforts to develop a synthetic genome.

Opening Plenary Session

Director of NCEA, Dr. Peter Preuss, opened the Plenary Session, welcomed all attendees to the fifth annual EPA-wide *Science Forum: Your Health, Your Environment, Your Future,* and provided an overview of the Forum's theme—the interactions of human health and the environment. Dr. Preuss acknowledged the cooperative efforts of CDC, ATSDR, and NIEHS in developing this event.

Welcome and Introductions

Dr. George Gray, ORD Assistant Administrator, discussed the theme of the 2006 EPA Science Forum and its intent to inform, educate, and empower the audience to play an active role in the science and research that affects the world in which we live.

The theme of this *Science Forum* is intended to illustrate the relationship between the environment and human health. This *Science Forum* brings together a diverse group of environmental and public health scientists who will present their work on some of the most challenging and significant scientific issues faced today. Over the next three days, the invited speakers, the seminar sessions, and the poster-platform sessions will highlight advances in science and some of the national and global environmental and public health challenges that science needs to address. Many of this year's themes are very timely and important, in light of many of the current discussions in the newspaper and on television—the potential for a bird flu pandemic; the use of nanotechnology; the potential for study of the human genome to help advance our understanding of human disease and its causes; and our response to natural disasters, such as Hurricane Katrina and the Southeast Asian tsunami. Yet, the interaction of environmental factors, defined very broadly, needs to include some of the things known to be important for determining our state of health—diseases such as diabetes and asthma, cancer, Acquired Immune Deficiency Syndrome, and the growing prevalence of obesity. The science discussed over the next few days will help to address these challenges.

This *Science Forum* emphasizes the importance of strong cooperation, coordination, and communication among the federal health agencies to help address the most significant public health and environmental challenges faced by this Nation and the world. Combining the diverse scientific and technical expertise of EPA, CDC, ATSDR, and NIEHS enables the presentation of a comprehensive and integrated analysis of emerging science concerns and some approaches for meeting those challenges. The involvement and participation of these agencies in the *Science Forum* is appreciated.

The topics presented in this *Science Forum* are interesting, cross-cutting, and broad in perspective. For example, there will be a platform session that focuses on the overarching topic of disease susceptibility—How do we understand it? How do we account for it? How do we take it into consideration when making public health decisions? Sessions held tomorrow will examine future challenges, including changing environments and disease patterns. All of the topics are intended to illustrate the breadth of what to consider when thinking about the environment and our health.

EPA and all of the federal agencies welcome increased participation from the public and the scientific community in addressing increasingly complex scientific, environmental, and public health issues. More perspectives, participation, and engagement will help everyone do a better job. Because public health issues and environmental issues are intricately linked, they cannot be considered separately. More will be learned by studying them together than by trying to study them in isolation.

EPA continues to build upon a 35-year legacy of protecting human health and the environment based on the best available science while still supporting a growing economy. Over the last 35 years, an ethic of protection has developed here in the United States that provides a different set of questions. The one faced now that we would all like to be able to answer is: How can we do this faster, with more certainty, and with better tools? EPA is announcing the release of the first independent advisory council report that evaluates the use of innovative technology by EPA to protect public health and the environment, and the development and use of technology by EPA to encourage sustainability, good decisions, and a decrease in the environmental footprint. The report, *EPA Technology Programs and Intra-Agency Coordination*, seeks to answer the questions regarding how to optimize the environmental technology programs and how to promote research and development, commercialization, and implementation of EPA-developed tools to solve some of today's problems, and recommends ways to incorporate other programs and activities to make EPA's work even more effective and to promote Agency goals. This report will be released on Thursday, May 18, 2006, and will be available at www.epa.gov.

Dr. Gray encouraged the audience to take part in all three days of the *Science Forum*, and to visit an area outside of their areas of expertise to build an appreciation and an understanding of the ways in which working together can advance public health and environmental goals.

Perspectives on Environmental Public Health

Dr. James H. Johnson, Jr., Dean of the College of Engineering, Agriculture, and Computer Sciences at Howard University, discussed the role of science in environmental policy.

There are two reasons why this topic is appropriate: (1) the mission of the Agency to protect the environment and public health, and (2) the Agency's unique role of both conducting research and using that research (and research conducted by others) to set environmental regulations and policies to protect public health and the environment. EPA is charged with understanding human and environmental interactions and protecting each. One of the mechanisms for doing this is through environmental regulations and policies. The final use of the information must be understood as the science is developed to support it. Dr. Gray addressed the question "Have we provided the best scientific basis for the development of environmental policies?" Answering that question requires consideration of whether the science being done right and whether the science is addressing the right questions.

The Board of Scientific Counselors (BOSC) was established in 1996 to provide advice and recommendations to the Assistant Administrator of ORD on issues ranging from human resources planning to evaluation of science and engineering research at the EPA Laboratories and Centers. Recently, BOSC has been conducting program reviews. One of the questions asked during the program reviews is "What is the scientific quality of the research products?" Six such program reviews have been conducted during the past 13 months. The reports and the Agency's responses to the reports are posted on the BOSC website. The responses to the charge question on the scientific quality of the programs' products are consistently positive and are described by words such as "high quality" and "consistent, superior, scientific quality." Therefore, the conclusion is that the science is being done right.

In order for this to continue, several key processes need to be kept in place. First, scientific results must be freely communicated to the scientific community and available to form the foundation of environmental policy. Second, Federal Advisory Committee Act committees, like BOSC, should continue to be independent of the political "litmus test." Third, the standards for peer review should be determined by the appropriate scientific community.

Is the science addressing the right questions? We may not always be answering the right questions. An inclusive process may not be uniformly used to help determine the right questions. For example, federal agencies have spent almost 1 billion dollars to assess the cancer risks of dioxin, and EPA is one of several agencies involved, but to date there have been no definitive, scientific answers, and many affected people are more concerned about the overall health risks to groups exposed to multiple hazards, not just the risk from dioxin exposure. The Clean Air Act (CAA) requires that the National Ambient Air Quality Standards be reviewed every five years for six major pollutants: particulate matter (PM), ozone, sulfur dioxide, nitrogen oxide, lead, and carbon monoxide. During this process, the Agency reviews recent scientific studies and translates results into policy recommendations. The initial reviews and recommendations are performed by the Clean Air Scientific Advisory Committee (CASAC). The Agency recently completed a study to determine ways to strengthen this process. However, some have questioned the motivation for the study and have speculated about incomplete adoption of the recent CASAC recommendations concerning PM.

Scientific understanding can be integrated with a deliberation process to ensure that the science is judged to be "decision relevant" and credible to all parties interested in or affected by the decision. Such a process requires the use of behavioral and social sciences. These sciences not only help policymakers organize decisionmaking to be well-informed and democratic, but also in understanding the human consequences of environmental policies and processes. Processes like this have been studied by social and behavioral sciences for years and have been proposed by the National Research Council (NRC) Committee on the Human Dimensions of Global Change. This approach can be applied to the environment as well as to the management and handling of nuclear waste.

As recently as 2005, a panel under the Committee's auspices completed a study on decisionmaking for the environment involving social and behavioral science research priorities. This study, co-sponsored by EPA and the National Science Foundation, recognized the challenges of setting environmental policy, such as the consequences of the choices that may extend for decades and that the long-term implications of wrong choices may be profound for both society and the environment. Other challenges include choices that affect phenomena that operate at multiple scales and the need to make decisions without scientific certainty or agreement on values. The report states "Participants with diverse perspectives and values should contribute to defining the environmental decisions that require analysis, framing the scientific analysis needed to gain insight with decisions, and interpreting the results to illuminate the decision at hand." This mandates early and continuous involvement of stakeholders.

The decisionmaking process described in the NRC report includes the following six elements:

- Clear identification of the decision to be made, which requires a consideration of science and the values of stakeholders
- Identification of a set of alternatives for the decision from a technical and values perspective
- Determination of the consequences and associated uncertainty of the alternatives based upon science
- Identification of the preferences regarding the trade-offs based upon values
- Selection of the preferred alternatives
- Consideration of implications for linked and future decisions based upon science and stakeholder values.

This process involves science and stakeholder value judgments throughout. Many times, the values expressed by stakeholders are only considered at the end of the process. The challenge confronted when this happens is that the finish line may not be the most important one for the stakeholders. Stated another way, the wrong set of science questions may have been answered. The need exists for an environmental policymaking process that is analytical, deliberative, and includes the values of constituents early in the process to ensure that the right questions are being answered. Doing this while the science continues with the current safeguards will increase the times when the right science is being done right.

EPA Commitment to Environmental Public Health

Marcus C. Peacock, Deputy Administrator of EPA, discussed EPA accomplishments and interagency cooperation over the last 35 years, and presented the first 21st Century Visionary Science Leadership Award.

EPA recently marked it 35th anniversary. The Agency's birthday present is cleaner air, water, and land for all Americans, fulfilling our obligation to leave the Nation's environment healthier than when we found it. Accomplishments by EPA over the last 35 years include greatly reducing automobile emissions, revitalizing inner city brownfields, cleaning up toxic waste, protecting and restoring the ozone layer, increasing recycling, and finding and promoting sustainable technologies. None of these accomplishments would have been possible without the high quality of science provided by dedicated EPA scientists. Interagency cooperation with CDC, ATSDR, and NIEHS is of vital importance, as evidenced in the responses to Hurricanes Katrina and Rita. For example, collecting and communicating vital information regarding the health and safety of affected persons would not have been possible without the cooperation and personal support of Director Julie Guberding at CDC. By working together, the Nation has the opportunity to accelerate environmental protection while maintaining economic competitiveness.

The 21st Century Visionary Science Leadership Award recognizes an individual or organization whose scientific research and outstanding leadership on emerging issues has helped to address complex problems around the globe, and created future advancements for humanity and all of life. Visionary leaders embody a sense of personal integrity, and radiate a sense of energy, vitality, and will. These are leaders who motivate others.

Dr. J. Craig Venter is the first recipient of the 21st Century Visionary Science Leadership Award. In 1998, Dr. Venter founded Celera Genomics for the purpose of sequencing the human genome using the whole genome shotgun technique, new mathematical algorithms, and a set of new, automated, deoxyribonucleic acid (DNA)-sequencing machines. The successful completion of this research culminated in publication of the human genome in *Science* in February 2001. To date, Dr. Venter's techniques have been used for the vast majority of all genomes sequenced in the world, and his research is now leading to the development of treatments and cures for diseases that affect millions of people around the world. More recently, Dr. Venter founded the J. Craig Venter Science Foundation and the J. Craig Venter Institute, which is a not-for-profit research organization dedicated to the advancement of the science of genomics, the understanding of its implications for society, and communication of those results to the scientific community, the public, and policymakers. Dr. Venter and his team at the Venter Institute continue to blaze new trails in genomics research and have recently published several important papers outlining advances in a number of areas including environmental genomics, such as characterizing more than one million genes found in the Sargasso Sea.

This award recognizes scientific leadership, personal integrity, and energy. Dr. Venter epitomizes these characteristics. He is a leader in science and continues to go beyond the limits of conventional thought to passionately serve the common good and is leading others down that path as we enter this century.

Opening Keynote Speaker—Secrets of the Human Genome

Dr. J. Craig Venter, President of the J. Craig Venter Institute, discussed some of the links from the human genome to the environment, and how they lead from one to another.

One key concept is massive parallelism, which is pretty simple in terms of computing. Instead of using one processor, thousands of processors can be linked together. The other key concept, which is likely to be more important, is randomness. Science has gone through various periods where it was believed that the knowledge had peaked. Almost always, those periods were followed by periods of massive discovery.

The first application of these techniques was to understanding genes expressed in the human genome. Ten years were spent in trying to isolate the adrenaline receptor by randomly selecting some complementary DNAs and sequencing them. The science went from sequencing one gene in 10 years to sequencing hundreds of genes in a relatively short period of time. The first paper was published in *Science* in 1991, and that paper seems minor now because only 337 new genes were discussed—a paper coming out soon will discuss 6 million new genes. Although the first paper seems like a minor effort, it changed the way that science was done with any mammalian genome. Databases now have over 20 million expressed sequence tags (ESTs), which currently is the top gene discovery method in the world. That is about to change with the environmental sequencing, but it is constantly growing with 10 million ESTs added in just the last few years.

Problems were encountered in addressing the large number of sequences encountered—hundreds of thousands of human gene sequences from a variety of tissues, yet with no good algorithms for assembling sequences. To remedy this, a new algorithm was built to assemble the sequences and the algorithm worked extremely efficiently, leading to the 1995 publication of a paper in a special issue of *Nature*. Roughly half of the human genes discovered with the EST method were assembled using this new algorithm. From there came the idea to try to sequence a microbial genome. At the time, there were two genome projects funded: the *E. coli* genome and the yeast genome, both of which took over a decade to complete. Using these new methods, the *haemophilus* genome was sequenced in only 4 months followed by sequencing most of the major human pathogens, and then increasing the size of the species, working up from plants, insects, and animals to humans.

The next big breakthrough after *haemophilus*, occurred at Celera Genomics with the *drosophila* genome. This required the development of a whole new algorithm with over a half million lines of computer code. After publishing the work on *drosophila*, the human genome was the obvious next step. The human genome was sequenced in 9 months at a cost of approximately 100 million dollars. Following the human genome, sequencing the mouse and dog genomes provided an opportunity to compare mammalian genomes. The dog genome shows distinct behaviors associated with genetics of the species, which provides an opportunity to sort out the genetics of behavior as well as traits. About half of the dog genome aligned very accurately with the human genome, which was more than twice as much than occurred with the mouse genome. The mouse is not a good model for human biology because the mouse genome is evolving at a much faster rate than other mammalian genomes. Dogs and humans are actually much closer, and much closer to a more recent common ancestor.

The chimpanzee genome also has been sequenced. In comparing the human and chimpanzee genomes and the regions that line up, there is only about a 1.27% percent difference between humans and chimpanzees. However, this data is somewhat misleading, because there is a lot of variation in mammalian lines that does not show up at the basic sequence level. When measuring indels (i.e., bases or groups of letters that get inserted or deleted from the genome), humans and chimpanzees differ from one another by about 5 to 6%.

In the near future, a new paper will be published on the human genome that will show that the difference between humans is much greater than people thought from just measuring a single base pair. These data will fundamentally change our views of own biology, our view of medicine, and how to deal with some of the complexities of our environment. The ideal would be to have a database of tens of millions or more of human genomes and all the associated clinical and phenotypic information. Only by doing multivariant analysis across all of these will it be possible to understand what is genetic and what is environment. Gene-based medicine exists and genome-based clinical research is beginning, but genomic-based medicine will only really happen when the technology and the computing power is available to deal with this information across the board. Research using single cells has found that life of even a single primitive cell cannot be defined based solely on its genetic code. One needs to know the genetic code and the environment. Only 3 to 5 percent of cancers are genetic, so most cancer is due to environmental changes, and this new tool of genomics can begin to be used to track that kind of disease.

After applying this technology to sequencing, applications that might aid in understanding the environmental component were considered. One such application involves a shot-gun sequencing of the ocean, which is the largest sink for exchange of carbon dioxide (CO_2). With deforestation and fossil fuels being the main driving forces for increased levels of CO_2 in the atmosphere, it seemed worthwhile to try to understand the biology behind the carbon exchange.

There are more microbes in biomass than from all plants and animals put together. Each milliliter of sea water contains 1 million bacteria and 10 million viruses, a very small percentage of which (i.e., 1 percent) are understood. This experiment took place in the Sargasso Sea, where there was supposed to be little, if any, life. This was found not to be the case; roughly 40,000 new species were found that not been characterized before. This started the Sorcerer II expedition, where sea water was sampled every 200 miles around the ocean to see if the diversity was the same or different than what was found in the Sargasso Sea. The Discovery and Science channel produced a 1-hour documentary on the expedition. Only 25 percent of the data collected matched known sequences. This was the first hint that the environment is very different than previously thought, and preliminary data analysis indicated that approximately 85 percent of the data was unique to each sample site (200 miles apart); only about 3 percent matched at every site. The data also showed a sharp demarcation between warm and cold sample sites; this was determined by looking at the microbial population by water sample location—the species are site-specific.

There are as many microbial cells in our bodies as genetic cells. What is in the air depends on what is blowing in the air. Although undetectable to the naked eye, there are now tools to measure this and to begin to measure the impact on health and disease.

For example, synthetic genomics is the construction of a genome. Synthetic genomic experiments have shown that a genetic code cannot be defined without also defining the environment. Efforts are underway to create a synthetic chromosome and the first synthetic bacteria may be developed within the next two years.

Synthetic genomics could have wide-spread applications. For example, some organisms can split water into hydrogen and oxygen. Within a decade or two, it may be possible to replace the petrochemical industry as our source of fuel.

In early 1996, a bioethical review was started that asked “Is it reasonable to make a synthetic cell?” That review, published in 1999, determined that reasonable approaches were being taken and research should proceed. The Sloan Foundation recently funded the Venter Institute, along with the Massachusetts Institute of Technology, to conduct a review. The third private meeting of the review is taking place in

Washington, DC, in May 2006, and will end with a large public meeting to develop good laboratory stewardship for all of the new laboratories conducting synthetic biology and synthetic genomics.

Genomics offers tremendous opportunities for change in the production of new vaccines and drugs, as well as new approaches to industry. Stay tuned because the world is changing very quickly.

Questions and Answers

The speakers had an opportunity to address questions from the audience.

A brief question and answer period addressed a range of topics. These included: (1) the loss of biodiversity due to human impact, (2) designing species with the aid of computer models, (3) the implications of indels on human health and human variation, and the stability of those indels, and (4) the need for an integrated database for human genome data.

Closing Remarks

Dr. Gray concluded the plenary session by thanking all of the speakers for taking time out of their schedules to address the *Science Forum*. Dr. Gray reminded participants of the poster sessions, poster-platform sessions, and exhibits throughout the *Science Forum*.

Section III: Disease Susceptibility Plenary Session

Tuesday, May 16, 2006

The purpose of this session on the first day of the meeting was to examine the relationship between disease susceptibility and the environment. An open discussion on susceptibility and disease, an audience question and answer period, and three poster-platform sessions followed the presentations.

Dr. Julian Preston, with EPA, and Dr. William Suk, with NIEHS, led this session on understanding why some succumb to illness while others remain well. Presentations addressed genetic susceptibility and responsiveness to environmental stressors and disease, understanding the link between disease and susceptibility to exposures at specific life stages, and health disparities between different social groups, including the implications for environmental health policy development.

Disease Susceptibility and the Environment

Dr. Julian Preston, with EPA, and Dr. William Suk, with NIEHS, led this session. Three speakers addressed linkages between genetic susceptibility, environmental stressors, and disease; linkages between life-stage susceptibility, environmental stressors, and disease; and health disparity impacts on policy development.

The Genome and Disease Susceptibility

Dr. Steven Kleeberger, Chief of the Laboratory of Respiratory Biology at NIEHS, discussed innovative work related to the genome and human disease susceptibility, the relevance of this new science to public health risk assessment, and recent advances in genomics, proteomics, and metabonomics. Common diseases, such as obesity, have been shown to have an important genetic component. Behavioral dysfunction, such as addiction, has also been shown to have a genetic component. These findings have sparked interest in the lay public and have motivated many to move further into understanding the genetic basis of disease, both complex and simple.

Childhood diseases and chronic adulthood diseases shown to have genetic components include mental retardation, asthma, metabolic disorders, birth defects, heart disease, diabetes, Alzheimer's disease, and arthritis. All of these diseases have been shown to have a very strong genetic component in terms of their pathogenesis in children and adults. Our ability to understand the role of genetics and the genetic background in susceptibility has been advanced tremendously by our understanding of the sequence of the human genome. Recently, the Haplotype Map project has provided a huge amount of insight in terms of genome structure that can be used to understand the genetic basis of diseases.

Genes are not the only factor important in the determination of diseases; they are only a small part of our makeup. The environment has a very spectacular impact on an individual's response to a pollutant, environmental stressors, and the pathology of disease. There are a number of other factors besides genetic background that could contribute to susceptibility and inter-individual variation in responsiveness to environmental agents. Extrinsic factors (such as socioeconomic status), physical forces (such as temperature and altitude), previous exposures to environmental agents, or exposure to different environmental agents may predispose an individual to respond to an environmental challenge. Intrinsic factors include gender, age, and nutrition/diet. All intrinsic and extrinsic factors can interact and ultimately define how an individual responds.

Asthma is a good example of a complex disease. There are multiple genes that contribute to asthma susceptibility. Environmental exposures are also very important in asthma, as well as the interaction of environmental exposure with genetic background. The public health importance of asthma is profound because there is an extremely high prevalence of asthma, with 15 million cases of asthma in the United States alone. Prevalence is higher in children, minorities, and those with low socioeconomic status. There is a high amount of morbidity related to asthma, including emergency room use, hospital admission, school and work absenteeism, and a decreased quality of life. More than 5,000 deaths a year are associated with asthma. The economic costs of asthma (as of 1994) are $10.7 billion each year. There are many groups investigating the etiological factors that contribute to determining whether an individual becomes an asthmatic.

The trends in asthma prevalence in last 20 to 30 years also are being studied. There has been a very marked increase in the prevalence of asthma in African Americans and in children between the ages of 5 and 14 in the last 25 years. The mechanisms through which this is occurring are not at all clear. Another question is: "What is causing the increase in asthma in industrialized countries?" While there is a role for genetic background in the pathogenesis of asthma (it is very well documented that certain phenotypes characterize asthma), the increase in the asthma trend cannot be attributed to genetics. The genetic makeup of a population will not change so dramatically in 25 years as to account for the dramatic increase seen in asthma prevalence.

What is causing it? Environmental factors are the most important. Studies have shown that exposure of young children to older children protects against the development of asthma. Children exposed to siblings or other children via day care have much less incidence of asthma.

Other environmental factors can influence asthma, such as air pollutants. Air pollutants are known to exacerbate asthma symptoms. Studies have been conducted that suggest that ozone can exacerbate asthma symptoms and also cause a greater incidence of asthma.

There also is evidence for genetic susceptibility to air pollutants. Current experimental work includes the pursuit of “candidate genes” for susceptibility to air pollutants. A gene called the “tumor necrosis factor” is a candidate susceptibility gene that modulates the inflammatory and injury response to ozone in mice. Quantitative trait loci on genes have been identified that associate with susceptibility to air pollutants. The results indicate that there are multiple sites in the genome that contribute to susceptibility.

Epigenetics is a revisiting of the Marx inheritance of acquired traits. Environmental stress can have an effect on gene expression, which can then lead to an inherited adverse outcome related to health. A 2004 review by Fineberg published in *Nature Genetics* indicates some of the mechanisms that may be important to epigenetic inheritance. One is DNA methylation; silencing a gene through methylation can affect expression of that gene. Epigenetic mechanisms have been associated with genomic imprinting, such that if there is differential methylation of genes in the parental or the maternal side, it is possible to differentially silence, or affect, the expression of that particular gene. This may be inherited. Methylation, acetylation, or phosphorylation of histones also can regulate transcription processes or transcription of genes as a result of this epigenetic paradigm. Proof of concept has been published in a number of publications. Environmental epigenesis is a very important factor that has stimulated the interest of a number of investigators in the past 15 to 20 years.

Genetic background is believed to be an important determinant of responsivity to environmental stressors and disease susceptibility. Greater understanding of complex diseases will be gained by investigating the interaction of genetic background with environmental exposure in the pathogenesis of those diseases. Epigenetic inheritance may have an important influence on disease phenotypes, and understanding the environmental factors or stressors that contribute to this process is critical in disease progression and very worthy of increased interest and research.

New Evidence in Life-Stage Susceptibility

Dr. Elaine Faustman, Professor at the University of Washington, discussed the concept of life-stage susceptibility and provided examples that illustrate the new directions being taken to understand this link to disease. To understand what is meant by life-stage susceptibility requires consideration of unique exposures, the toxicogenetic and toxicodynamic responses that occur after those exposures, and the myriad of outcomes that can result from those exposures. This utilizes a risk assessment concept.

Two categories for this discussion on the susceptibility of children to toxicity are toxicological considerations and exposure considerations. Toxicological considerations include temporal differences in susceptibility, dose response considerations, and genetic susceptibility.

In the 1980s, Wilson looked at developmental biology, embryology, and teratology to identify windows of susceptibility that occur during periods of differentiation; these were defined as periods being highly susceptible to birth defects. Current knowledge is that, depending upon the times of exposure, there can be various outcomes. The paradigm promoted consideration about windows of susceptibility to define key processes that underlay these time points of vulnerability, but in itself is becoming less efficient to describe the myriad of events being seen.

Early *in utero* impacts can lead to effects on asthma and also potential effects in neuro-degenerative pathways. Early on, these windows of susceptibility were defined by the key processes that were occurring, such as proliferation, differentiation, and migration. Our understanding of the specificity of these processes has increased over the years to be able to talk on the organ level and sub-organ level about the timing of these events.

Tissue specificity, temporal specificity, and dose specificity need to be understood as they provide the context for early definitions of windows of susceptibility. As more information is gained about the functional role of different neurotransmitters, an important issue is that there are very strong differences across species. Rats and humans display different temporality. So, windows of susceptibility now are defined by regional events occurring in sub-organs and then by different processes occurring in different combinations.

What roles have models played in this? This is one area where there has been quite a bit of work in understanding normal processes of neurodevelopment. An early construct for a neo-cortex model illustrates a method to understand and provide some quantitative context for the roles that proliferation, differentiation, and apoptosis might play in overall normal and chemical-perturbed processes. One of the most striking things that came out of this research is the idea of strong dose and time relationships. In addition, it has been known for some time that resistant strains are not always resistant, and sensitive strains are not always sensitive. Such classification provides a context for the compound and also the organ system. This illustrates the complexity of actually identifying life-stage susceptibilities.

Both the Children's Center and EPA have been examining the varied types and frequencies of childhood exposure, age-specific behaviors, and the toxicokinetic considerations that underlie these exposures. Understanding what children do, when they do it, and how frequently they do it, has actually contributed a lot to understanding the potential for susceptible populations to have exposures. One pesticide study examined the percentage of time children spend in the home, in vehicles, outside, in school, and in businesses (e.g., stores). Exposure measurements (in this case to pesticides) were conducted in vehicles and homes, then correlated with urinary metabolites. This made it possible to establish "take home" exposure pathways for children in agricultural communities. These studies have been extremely helpful.

What about the next level of understanding life-stage specificity? In this case, it is not only exposures, but also the capability to metabolize the exposures. There is a lot of work being conducted on the enzymes present in different stages of development. In all three pathways studied and in the multiple enzymes that are present, polymorphisms have been found that contribute overall to the genetic susceptibility of individuals. *In utero*, both mother and child have different portfolios of susceptibility at different times.

The NRC report, *Scientific Frontiers in Developmental Toxicology and Risk Assessment*, laid out a series of challenges to examine what genomic conservation might mean for life-stage susceptibility. This is very detailed work on a gene-by-gene basis put into the context of an overall organogenesis. The report also identified key pathways: molecular-stress pathways, checkpoint pathways, and apoptosis pathways. For example, the pathway for oxidative stress is extremely important in defining responses to many environmental agents. One of the hallmarks of aging is the decreased ability to respond to oxidative stress. The study showed that this particular pathway may be important in defining age-related susceptibility. Therefore, some of the lessons learned in studies of development also are relevant to other life stages.

Health Disparities

Dr. William H. Sanders, Acting Director of the Office of Children's Health Protection and Environmental Education (OCHPEE), provided an overview of the national health agenda regarding the issues of health disparities and environmental health, and discussed government responses, research needs, and the path forward. Disparities in health and health care persist in this country. Recognizing this, how can we move forward? How does our environment shape disparities in health, morbidity, and mortality? What, if any, is the role of EPA?

One of the important goals articulated in *Healthy People 2010* is the elimination of health disparities—the gap in morbidity and mortality between social groups (e.g., racial, ethnic minorities, and low income populations). *Healthy People 2010* is built upon the concept of determinants of health, where individual biology and behaviors influence health beyond and through their interaction with each other and with an individual's social and physical environments. In addition, policies and interventions can improve health by targeting factors related to individuals and their environments, including access to quality health care. A good example is the amount of attention and resources focused on lead. The lead and neurotoxin objectives of *Healthy People 2010* are to eliminate elevated lead blood levels in children and to reduce the occurrence of developmental disabilities. Reducing disparities is part of the national agenda and part of the EPA strategic plan.

Definitions are important because they can have policy implications. The term "health disparities" is most commonly used to suggest that disparities are simply differences between groups. It is more than just that. There should be a hint of moral concern, such as that found in a definition posed by Dr. Paula Braveman, from the University of California, San Francisco School of Medicine: "A health disparity/inequality is a particular type of a difference in health or in the most important influences on health that could potentially be shaped by policies; it is a difference in which disadvantaged social groups systematically experience worse health or greater risks than more advantaged groups."

EPA programs focus on the physical aspects of the environmental, principally chemical stressors (e.g., pollution). This focus, alone and in a vacuum, is insufficient. Environmental justice advocates have encouraged scientists and regulators to consider the social, economic, and political context in which exposure to environmental chemical hazards occurs, and to consider the impacts that socioeconomic and other social factors have on resulting health outcomes. It is important to think about both social and physical environments.

The World Health Organization (WHO) offers an excellent definition of environmental health that is broad and calls for cross-disciplinary programming and thinking, which ultimately can lead to better interventions and policies. WHO also talks about including quality of life as determined by chemical, physical, biological, social, and psychological factors.

What do we know and what does the science tell us? Racial and ethnic disparities in health have been well documented in a broad range of medical conditions. For several of these health concerns, environmental conditions and exposure to environmental contaminants are thought to play a role. Researchers have also identified pre-existing health conditions that may be exacerbated by air pollutants or that may render people more susceptible and vulnerable to environmental pollutants. Some examples include heart disease, cancer, autoimmune disease, and respiratory ailments. Research informs us that social and physical factors impact health and contribute to health inequality. Identifying these factors and how they interact with one another will help to better understand the mechanisms and some of the fundamental causes. Because health disparities are typically observed to be population differences, explanations and solutions are more likely to be found at the population level than at the individual level.

The built environment also contributes to air pollution. There are many examples of proximity to polluting facilities and landfills for people of color in low income communities. There are well documented disparities between high and low socioeconomic status exposures. Education is another way research is used to measure socioeconomic status. Psychosocial stress, due to crowding, noise, social disorganization in neighborhoods, and economic depravation, has a direct impact on the immune system. Current research has illustrated the relationship between the social and physical environmental factors that contribute to health disparities. Racial residential segregation, where different ethnic groups live apart from one another due to structural and historical forces, has been associated with a variety of health outcomes. One hypothesis is that segregation concentrates social disadvantage (e.g., poverty), which in turn leads to adverse health outcomes.

Using racial composition does not get to the underlying cause, but using a measure of segregation does. Scientists are beginning to explore the relationships between segregation and physical environmental hazards, such as how segregation contributes to disparities in exposure to environmental contaminants. Recent studies suggest that exposure to air pollution may be one pathway through which residential segregation is associated with health disparities. Social factors have also been shown to amplify the health effects of exposure to environmental contaminants, creating a condition of differential vulnerability to such contaminants. Inner city minority populations are high risk groups for adverse birth outcomes and also are more likely to be exposed to environmental tobacco smoke.

What is EPA's role? There have been a number of efforts that contribute to understanding the science and to developing initiatives to eliminate health disparities. Two important meetings have laid out agendas to address health disparities. One is the 2003 Health and Human Services Office of Inspector General Symposium, which provided an overarching framework for federal agencies to work together. This symposium was the first to explore the intersection between health disparities and environmental justice, and the ways in which federal agencies can develop proactive, comprehensive, and integrated strategies to build healthy environments and address communities suffering from health disparities. One of the themes was effective partnership development and capacity building of communities to address environmental health and sustainability issues. Recommendations on the federal collaboration included organizing training, developing education materials, and sponsoring pilots to advance projects. Another important meeting was the 2005 EPA/NIEHS/University of Michigan Workshop, which was designed to develop a scientific foundation and to explore conceptual issues, data needs, and policy applications with regard to the social and environmental factors used to measure and track racial, ethnic, and class disparities in environmental health, recognizing that as programs to reduce and eliminate disparities are implemented, ways to measure progress are needed. Recommendations included the development of a set of indicators that can be used to assess environmental health disparities and more proactive engagement of federal, state, and local agencies.

OCHPEE has been engaged in several efforts to address disparities in children's' environmental health. There is a small grant program to build capacity of local health care providers in identifying risk at the community level. Prenatal Partnership on Environmental Health is a new program that will provide educational materials on the environment and safe pregnancy. The target population will include low socioeconomic status women, women without access to health care, and women with less education. On the path forward it will be important to:

- Understand the pathways to unequal exposure and diseases related to the environment

- Understand more about interactions between social factors and exposure to environmental toxins
- Develop methods EPA and others could use to incorporate social determinants in risk assessment and risk management
- Develop assessment/monitoring tools (e.g., indicators, equity impact assessment methods)
- Form collaborations between environmental and social sciences.

Questions and Answers

The speakers had an opportunity to address questions from the audience.

A brief question and answer period addressed a range of topics. These included: (1) the state of the science in terms of characterizing the genetic component of asthma in humans, (2) the importance of environment in the pathology or pathogenesis of asthma and asthma sub-phenotypes, and (3) the need to recognize the disparities in information, to determine what information is needed, and ways to measure success.

Open Discussion on Susceptibility and Disease

Are we getting information out to the socioeconomically challenged and other communities?

There are papers that may not necessarily get out to communities. We are not there yet. A lot more still needs to be done.

Regarding population vulnerability, how optimistic is it that a concept such as population vulnerability will work its way into how the Agency does things?

The Agency always focuses on those that are at the most risk. As knowledge increases, resources can be targeted more effectively. As we continue on the path to understanding what has to be done differently, socioeconomic factors are likely to be incorporated into our risk assessments.

The Food Quality Protection Act (FQPA) requires EPA to apply an additional 10-fold safety factor in setting regulations with respect to exposure to pesticides for children's protection. What is the reliability and completeness of the database, particularly with respect to developmental neurotoxicity related to organophosphates in connection with applications to the FQPA?

From an academic standpoint, a lot of the studies did not include the appropriate kinetics, so kinetic models were applied to all of the studies to see if the outcomes could be explained. Only a handful of the organophosphates had neural outcomes of interest. From a standpoint of databases, there are studies out there, but they do not tell us what we need to know. More coordination is needed to pull the information together to answer these public health questions.

There is some concern as to whether EPA has the tools to assess the cognitive effects on children and uncertainty as to whether the academic community has access to those studies.

Nobody has those tools yet. It is extremely complex. Microdiversity might be considered.

Current risk assessment methods tend to assume a default value of 10-fold variability in human susceptibility to chemical exposure. To what extent does current understanding about susceptibility, either in terms of response or metabolic pathways, confirm or expose gaps in understanding whether or not that default assumption is sufficient?

There are a lot of in-house tools to help answer that question. Assumptions are used when there is no information. If better information existed about variability, assumptions would not need to be used.

What is the vision for using the talent and expertise within the environmental education community to help address some of the issues in terms of children's health and other health disparities?

There is a need to reach out within the Agency and to the communities. There is work that needs to be done out of the Office of Education. There is a lot that has been done that needs to be communicated to the rest of the Agency.

Two populations were not discussed – tribal and those who are chemically sensitive.

Native American populations were not discussed in this session, but it is a group about which EPA is very concerned. Also, the current understanding is not sufficiently complete to identify (through genetic or other factors) if one person is going to be more susceptible or not, but that is certainly the current direction.

There is an expanding database for the drug side. A short battery of tests can be conducted to figure out which drugs are safe and which drugs should not be used again.

That refers to pharmacogenetics and pharmacogenomics; those fields have polymorphisms and metabolizing enzymes that could predispose an individual to a particular adverse outcome to a drug. The science is closer to understanding those sorts of specific responses than responses to an environmental agent.

Did the reference to populations living on farms involve raw milk and fresh vegetables?

Yes. Those studies were conducted in small European towns where the families lived next to or over the stables. Drinking raw milk is another way children are getting exposures and stimulating their immune systems.

Poster-Platform Sessions

Dr. Andrew Geller (with EPA), Dr. Bruce Fowler (with ATSDR), Dr. Julian Preston (with EPA), and Dr. William Suk (with NIEHS) chaired three concurrent poster-platform sessions elaborating on the three plenary topics:

- The Genome and Disease Susceptibility
- New Evidence in Life-Stage Susceptibility
- Health Disparities.

Section IV: Global Challenges Plenary Session

Wednesday, May 17, 2006

The purpose of this session on the second day of the meeting was to examine the relationship of the changing environment to new public health challenges. Three poster-platform sessions followed the presentations.

Dr. Anne Grambsch, with EPA, and Dr. Chris Portier, with NIEHS, led this session on how a changing environment is giving rise to potential new public health risks, and actions that could be taken to ameliorate these risks. Presentations included new public health challenges that are arising from changes in global stressors, changes in environmental health risks and underlying risk factors, the continuing evolution of the risk assessment process, and interagency cooperative efforts that have reduced health risks in the United States related to air and water pollution.

Global Challenges

Dr. Anne Grambsch (with EPA) and Dr. Chris Portier (with NIEHS) led this session. Four speakers addressed new public health risks arising from changes in global stressors; how changes in human behavior, global transportation patterns, and extreme weather events are changing diseases and public health threats; future directions for risk assessments; and interagency collaborations, nationally and internationally, that address environmental public health challenges.

Changing Environments

Dr. Rita Colwell, distinguished University Professor, University of Maryland at College Park and Johns Hopkins University Bloomberg School of Public Health, and Senior Advisor and Honorary Chairman of Canon U.S. Life Sciences, discussed the new public health challenges that are arising as global stressors change, and the implications of these changing stressors for human disease. A global context frames human health issues in the 21st century. Earth processes operate on a global scale, and infectious diseases still cause a quarter of the deaths worldwide. However, information today travels as fast as the diseases, which enables quick responses. Diagnostics is a new development. One prediction is that there will be hand-held genetic sequencing devices that will enable rapid assessments to be made by emergency responders in the not so distant future.

Infectious disease is a moving target. As the climate shifts, diseases will be affected. There is a need for new proactive approaches, rather than reactive approaches, to protect human health. Investigators have shown a link between climate and disease outbreaks. Disease outbreaks often have a distinctive and seasonal pattern; increases in temperatures can lead to increases in disease incidence.

Cholera is a good example of the bio-complexity of disease. The most recent data, from 2004, indicate that there are 60,000 cases of cholera and 2,000 deaths attributed to this disease each year. This data does not include cholera cases attributed to the Bangladesh monsoon season nor the varying intensities of monsoon seasons. Research has shown that the bacterium is a naturally-occurring environmental bacterium found in estuaries and bays around the world. The disease cannot be eliminated from the planet. Although cholera organisms may go into a dormant stage, these organisms are intact, viable, and capable of producing the disease. Plankton carry the bacteria in very large numbers. In Bangladesh, the incidence of cholera epidemics in the spring and fall are associated with the "bloom" of plankton at those times. Deep-sea copepods also are very high in cholera organisms.

Microorganisms can be detected using gene probes, and this provides an opportunity to understand the organisms in the environment with greater accuracy than ever before. Data characterization has shown that there is distribution in layers in the ocean; thus, it is possible to characterize organisms that are potentially pathenogenic and could become abundant and cause outbreaks. There are organisms common to all ocean depths and there are organisms common only to certain ocean depths (e.g., deep depths). The fluctuation of particular populations (e.g., plankton) within an aquatic system affects the incidence of disease. Research has shown that the environment represents a lot of surprises that may be faced in the future. Emerging and reemerging diseases will be a major problem in the next decade or so.

There is a correlation between warm sea surface temperatures and high incidences of cholera. Parameters associated with cholera outbreaks, such as sea surface height, plankton blooms, and el Nino patterns, provide factors that enable prediction (through satellite imagery) of cholera outbreaks. Using this kind of data, it was possible to precisely predict cholera epidemics in Bangladesh in 2005, including when, where, and how severe the epidemics would be. Satellite data were used for the calculations and a Bangladesh hospital was contacted to ask about the actual reported values. The calculated predictions using satellite monitoring data were very accurate. Using scientific data gathered to provide the knowledge to villagers, some studies were conducted that suggested how the use of a simple filter may reduce cholera. A cloth folded eight times was found to provide a 20-micron filter, and it was possible to reduce cholera cases by 50 percent simply by educating the women who collect the water on the use of the cloth filter. The research currently underway is determining the health status of families who have continued to filter their water using these cloth filters.

We are now facing the avian flu, and its evolution is being followed through genomics. The number of cases has been increasing. There are few means to protect ourselves from this flu, aside from slaughtering the infected birds and developing an immunization in time. A systems biology and systems ecology approach will allow infectious diseases to be probed in a way that could not be done before. Therefore, it is necessary to step out from the old paradigms. Infectious diseases are international problems that require international collaboration.

Changing Diseases

Dr. Howard Frumkin, Director of the National Center for Environmental Health (NCEH) and ATSDR, discussed the threats to public health that are changing in response to a changing environment, the changing picture of environmental health, and how new research and technologies can be used to track and guide efforts to address these public health threats. CDC was founded 60 years ago as the Communicable Disease Center to help control malaria, typhus, and other communicable diseases. Now, as a federal agency within the Department of Health and Human Services, CDC has the primary role of serving the Nation's efforts in public health. The main operating units are the national centers, organized around public health themes with a focus on diseases and health.

The epidemiology transition is the basic paradigm used. Environmental health risks such as sewage, solid waste, drinking water, and vector control have plagued cities ever since cities were built, but the major challenge is disease. In the late 20th century, toxic chemicals and pollutants took center stage, resulting in the increase in diseases such as cancer and reproductive and neurological toxicity. Emerging environmental health risks include global climate change, the built environment, nanotechnology, and gene-environment interactions.

To determine which populations are most at risk, demographics and age must be examined, among other factors. The major causes of death today are chronic diseases (e.g., pulmonary disease, stroke, etc.). More classical causes of death are also major causes of disease (e.g., bronchitis, respiratory disease). The major victims of several of these leading causes of death are children and on a disproportionate basis. WHO has studied the evolution of disease burden over time. In the 1990s, respiratory and diarrheal (sanitary) diseases topped the list. In 2020, it is predicted that heart disease and major depressions will top the list. There is a rapid rise of chronic disease that will account for 70 percent of the global burden in 2020. Depression will rise to 5 percent and violence will rise to 41 percent. Motor vehicle crashes are a major cause of death for people in their twenties.

WHO has tried to answer the question of who bears the disease burden. The majority of the burden falls on the poor parts of the world. A report by WHO defines the causes of diseases and includes many risk factors, with unsafe water and indoor use of fuel at the top of the list. A few important diseases for consideration are diarrheal diseases, acute respiratory illness, mental illness, motor vehicle crashes, chronic disease/obesity, and emerging or re-emerging infectious diseases. These six diseases are of particular importance due to their cost (in terms of health) and their environmental components. Each of them has an environmental contribution, and there are environmental interventions to reduce the incidence of each of the diseases. Motor vehicle crashes are rising rapidly in the developing world as the cause of death. Mental illness causes major morbidity and suffering, and is trending in the wrong direction. Diabetes and obesity are trending up in much of the world.

Diarrheal diseases are extremely important world-wide. Half of the people in the world do not have safe water. The solutions to unsafe water are not complex, but they are difficult to implement. Even the United States is not free of water contamination, and has experienced waterborne outbreaks of disease. These occurrences often have a correlation with extreme precipitation events. Rainfall washes pollutants off of land or structures and into the drinking water supply.

Acute respiratory diseases are affected by both indoor and outdoor pollutants. Poverty plays a role in susceptibility. Children are affected by bio-fuel burning because they spend a lot of time indoors. One week out of five, children are affected by an acute respiratory infection. It is a very large disease burden, the highest burden falling on Africa and South Asia. Although the United States has come a long way in reducing outdoor pollutants, they are still a major concern in the rest of the world. Cleaner vehicle alternatives and energy sources, as well as less energy demand, are needed. There also is a need to reduce, reuse, and recycle.

Mental illness is very common in developed and undeveloped countries, and aggravates the burden of heart disease. There are four environmental factors that influence mental health: light, commuting, ugliness, and nature deficit. Natural light is effective as an anti-depressant. Commuting increases the incidence of road rage, anxiety, and impulse-control disorders. Environmental ugliness makes people feel glum, and children do not have access to nature anymore. If we create environments that deprive children of access to nature, we are contributing to the burden.

The burden of motor vehicle crashes falls on developing countries. These countries are adding more cars, but do not have enough medical services to deal with crashes. In the United States, more recently developed cities have higher incidences of motor vehicle crashes.

Obesity and diabetes are on the rise. This trend may result in children living fewer years than their parents. As a population, we are too sedentary.

Global climate change is the single factor that deserves most of the attention in this regard. The WHO intergovernmental panel on climate change predicts that malaria is most likely to change its range under climate change scenarios.

Changing Assessments

Dr. Peter Preuss, Director of NCEA, discussed what has been learned about human health risks, how those risks are currently evaluated, and what changes need to be made to move risk assessment into the future. The current thinking about risk assessment needs to continue to evolve. The current approach was developed about 30 years ago to examine a single chemical or pollutant and a single exposure route, but things are changing. There have been major advances in recent years in pharmacokinetic modeling and in the statistical and biological thinking involved in the modeling—How do people metabolize and transport a chemical when exposed to it? To get a better understanding of the boundaries, much effort is spent on the mechanism (mode)—How does a cell give rise to tumor? Now, a fair amount of time is spent looking at uncertainty, both quantitative and qualitative, as well as multiple agents, pollutants, and routes of exposure.

Cumulative risk assessment considers the broad set of things a person may be exposed to, and essentially looks for etiological factors of disease. Combined risks from multiple sources or stressors and social factors also are examined, including whether community resources are adequate to deal with the problems being faced, the community stress, or impacts on life-stage or coping factors. These community factors may make people more susceptible. Community factors can be further subdivided to look at genetics, epidemiology, etc., that result in increased risk for the exposed person. It is important to look at all of these factors and to try to understand more broadly what is causing individual and/or community risk.

Integrated environmental assessment recognizes that there is an interaction between the ecosystem and people that feeds into human well being. There are a series of indirect drivers of change (e.g., geography, economics) that result in the direct drivers of change (e.g., land use, species reduction, and change in species). These kinds of drivers, which affect human well being and issues of poverty, are based on a concept of ecological services. The Millennium Assessment looked at this on the global level (the average trends of species worldwide) and placed the human being at the center. However, it also considered the consequences of ecosystem changes for human beings and other life on earth as well as ecosystem services and how people benefit from them around the world.

We are faced with several important paradigms, all of which need continued work. EPA has developed a toxicology department to bring the huge amounts of data produced around the world into EPA assessments. As assessors, EPA is challenged with determining how to collect and integrate data on different scales and determining when to take the broader approaches. It is important, as an assessment community, to think about how to incorporate these things to give a better description of what is causing ill health and lack of well being.

Changing Responses

Dr. Michael Shapiro, Deputy Assistant Administrator of the Office of Water, discussed how federal health agencies in the United States have worked together to achieve remarkable successes in reducing risks related to air and water pollution, and how international agencies, federal health agencies, and state and local health departments are working to meet new challenges to environmental public health. As risk mangers and as a society, we have proved we are capable of integrating information about threats and responding with creative and effective approaches to those risks. An example is the degree to which we, as a society, have responded to some of the disease challenges associated with water through treatment. Prior to water treatment, there were many typhoid-related deaths. However, as a result of water treatment, the level of typhoid incidence decreased and was virtually eliminated by 1960.

Even before the biological mechanisms were understood, a correlation was known to exist between contaminated drinking water and disease incidence, and filtration and treatment of water with chlorine occurred before the creation of the Clean Water Act; the first bacterial standards were in place in 1914. As public health officials, we are able to take effective measures, resulting in enormous gains in human health, using only the information at hand. In 1974, there was a growing awareness that some issues would require strong national action to address. Two fundamental approaches were embodied in the Safe Drinking Water Act: a foundation of national standards based on the assessment of health consequences, and establishment of acceptable levels to protect the majority of the population.

Since 1970, incidences of bacterial and pathogen disease-related outbreaks have continued to occur, although they have decreased over time. However, the 1993 outbreak of *Cryptosporidium* in Milwaukee was a wake-up call, forcing re-examination of the layer of protection used and addressing a broader array of challenges than in the past. The outbreak placed a higher stress on the treatment of surface water supplies—beyond chlorination to include filtration. There is a relationship between water-related outbreaks and storm water events. Even today, the exceedence of indicator organisms is the single largest impairment of water in this country. WHO estimates that a large portion of the world's population uses water from unapproved water sources.

The most dramatic incidence of air pollution in the United States occurred in Donora, Pennsylvania, in 1948. The level of pollution resulted in 7,000 hospitalizations for acute illnesses and 20 deaths. The cause of the illnesses and deaths was intense smog from heavy pollution and environmental factors. This incident led to the development of scientific criteria to set safe levels of air pollution through the 1970 CAA. In 1990, the CAA was amended, resulting in new tools for protecting human health. The CAA is a set of standards for primary pollutants and a set of technology requirements to provide national consistency. The CAA has been incredibly successful in reducing the impacts of air pollution on our Nation. Air pollution has been reduced by over 50 percent from 1970 to 2004, resulting in dramatic human health gains.

Global cooperation is needed to ensure the health and safety of the world's population. For example, scientific studies in the 1970s and 1980s resulted in the consensus that chlorofluorocarbons (CFCs) were threatening the ozone layer and that would result in numerous adverse health outcomes including a rise in the incidence of cancer. Subsequently, the Montreal Act established controls for eliminating CFCs, and resulted in almost complete elimination of their use in the United States. Some scientists say that a reversal in the decline of the ozone layer is being seen, and there may be an increase in the ozone layer level as a result of these actions.

We have acted on the basis of good science. We can, and often have to, act before the clear scientific picture is drawn. It is not necessary to have every last piece of information before taking effective action, and the tools have evolved over time.

Emerging issues present plenty of challenges. In keeping up with the gains already made, a sustainable infrastructure needs to be constructed. We have neglected to invest in what we already have. There is a need to partner with utilities to maintain the infrastructure within the United States, and we also need to consider the changing scale of response. Our most important problems will not be solved by writing a national regulation, and we cannot hope to use industrial models. Organizations at all levels in our society will have to work collaboratively and internationally. The success of the Montreal Act is the result of a complex web of international partnerships at many different levels. This is a great time for scientists to be talking to the risk managers who are trying to make the best use of the information that scientists are developing.

Poster-Platform Sessions

Dr. Mike Slimak (with EPA), David Bussard (with EPA), Dr. Andrew Geller (with EPA), Dr. Bruce Fowler (with ATSDR), and Dr. Chris Portier (with NIEHS) chaired four concurrent poster-platform sessions elaborating on the four plenary topics:

- Changing Environment
- Changing Diseases
- Changing Assessments
- Changing Responses.

Section V: Former EPA Assistant Administrators for Research and Development

Wednesday, May 17, 2006

This session on the second day of the meeting was held in recognition of EPA's 35th Anniversary Celebration, and provided an opportunity for five former ORD Assistant Administrators and the current ORD Assistant Administrator to discuss current and future science challenges facing EPA. An audience question and answer period followed the presentations.

Current and Future Science Challenges Facing EPA

Dr. George Gray, Assistant Administrator of ORD, welcomed attendees to this special session—an opportunity to chat with five former ORD Assistant Administrators, spanning 25 years of Agency history. The former ORD Assistant Administrators shared their views of their EPA experience as well as some of the challenges and opportunities that face science and EPA in the future.

Dr. Paul Gilman, Assistant Administrator of ORD, April 2002 to November 2004

EPA is the only remaining regulatory agency with a significant research and development component. Therefore, the Agency has a special responsibility to continue to demonstrate that its science, research and development, and engineering is responsive to the mission, yet understands that it has to be looking outward and that there has to be a basic component to it. This event embodies a regular renewal on the part of the Agency and outreach. To see friends from NIEHS and industry and the like who have a role in research in their own rights is the kind of outreach that is so important for the Agency to do its work well and to continue to have a robust research program that serves its mission. It is a testimony to the Agency that industry, nongovernmental organizations, and others have been very supportive of the research arm of EPA.

There will be a continuing need on the part of the Agency to demonstrate excellence and utility in what it does if it is going to be that sole remaining regulatory agency with a substantial research and development component. That means being able to bring in the new tools and the new blood. Many people within EPA will be retiring soon. The post-doctoral program will help to fill those vacancies. I recognize it is a challenge, but one that has been met so far. Congratulations and good luck for the future.

Dr. Norene Noonan, Assistant Administrator of ORD, October 1998 to January 2001

The *Science Forum* is terrific. It has grown, become so much more robust, and there are some fabulous posters. Thanks also for the post-doctoral program. I am currently the Dean of Sciences and Mathematics at the University of Charleston in South Carolina with a recent hire from the EPA post-doctoral program in chemistry, and we are thrilled to have the opportunity to benefit from that wonderful program. I want to echo Dr. Gilman's comments about excellence. Remember our motto: excellence and relevance.

I encourage you to continue to pursue that path and to focus on three big things. The first is people—the people that you have, the people that you will have, and the people that you will impact in the community through the graduate fellowship program, the post-doctoral program, and the Science To Achieve Results (STAR) program. Those people are vitally important, not only for EPA and ORD, but for the scientific community throughout the country. Those are our future science leaders.

The second item is ideas, knowledge, and innovation. EPA has to continue to be a leader in those areas, not only in human health, but also in eco-health and eco-understanding. We still do not do a very good job of integrating those two.

Lastly, is a focus on tools and infrastructure. Tools make things possible, and are often the only way possible to do certain things. Continued development is necessary not only of equipment, but also the knowledge tools—the informatics tools that will be needed in the future. I encourage all of you, particularly those of you that are managers, to remember that you all can be leaders at every level. Please take the Agency forward. We are counting on you.

Dr. Robert Hugget, Assistant Administrator of ORD, August 1994 to May 1997

Some issues have not changed, but some issues that were unanticipated and certainly not previously considered have bubbled to the top. An example is the environmental impacts of nanotechnology where there are no standard methods for bioassays or detection. Nanotechnologies are discussed as if they were chemicals and not elements or compounds. This will be a challenge for EPA in the next decade. Another example is genomic technology. Recent publications of transgenerational effects due to chemicals are frightening, and include rat and mice studies that show a disproportionate number of males in the fourth generation after exposure. This may drastically change the way we think about risk.

Pharmaceuticals and personal care products are a big problem for surface water as evidenced by the endocrine effects already being seen—male small-mouth bass in the Shenandoah River are producing eggs. Sweden passed resolutions that ban pharmaceuticals in surface water and mandate that physicians first prescribe the most environmentally benign drugs for a disease. Environmentally benign is being defined by toxicity, persistence, and bioaccumulative capacity. Should EPA also certify pharmaceuticals, along with the Food and Drug Administration, if we know they are going to get into surface waters? The statutory ability to do that may already exist, but such EPA involvement is not occurring. This is going to be a bigger and bigger problem in the future and we need to start considering it.

The future will certainly focus on these areas, but in 15 years, if not sooner, our thoughts will be dominated by the effects of global warming. The predictions now are for the sea level to rise by as much as 13 feet by the next century. Think of all the landfills and cities that will be flooded and the impact that is going to have given all of the agricultural land, which is currently laced with pesticides and other things, that will be underwater. Over the years, the Agency has evolved in a “Steven J. Gould-punctuated evolution” fashion, where everything remains constant until some big environmental perturbation, and then it changes. Some may remember the Cuyahoga River catching on fire, which brought about a big change. Hopefully, the Agency, through strategic planning and decisions, can stay abreast of these new developing areas and be able to cope with them as they occur. You are a great group and I have all the confidence in the world you can do the job.

Mr. Eric Brethower, Assistant Administrator of ORD, February 1990 to January 1993

I entered the Agency when it was young and new, which was an exciting time. There was a huge amount of concern about the environment and everyone wanted to be involved. A lot of things happened very quickly, and we watched the Agency being formed. The CAA, Clean Water Act, Toxic Substances and Control Act, Safe Drinking Water Act, Resource Conservation and Recovery Act, and Superfund all came about in a relatively short period of time. The Agency sometimes struggled a bit from insufficient Congressional direction, and had to determine the exact path many times, which was very controversial.

Through all of those decisions and years, the Agency grew and devoted its resources to implementing those main Acts and did a fantastic job. Every report indicates that the rivers and air are cleaner; hazardous waste sites have been cleaned up; new ones have been prohibited; and drinking water is safer. This is a huge public health story and a huge success for EPA.

There appears to be a growing political movement to do something about climate change. That is going to take a while. There is a lot of building that has to be done, but it will happen in the not too distance future. The Agency will again be challenged in terms of what to do. There will be a large amount of growth again, and EPA will do it like it did in the past—very well. I had a fabulous career at the Agency. The people I worked with were splendid. Thank you so much.

Dr. Bernard Goldstein, Assistant Administrator of ORD, November 1983 to August 1985

What I learned here at EPA was that the people to listen to were those in the field doing the work. I do not think that has changed at all. The integrity of your science is crucial for the credibility of this Agency. Moving ahead with the environmental challenges we have depends so heavily upon having a credible EPA. That is the only way to be able to deal with the many issues that you have heard about. The opportunities are exciting: the new science moving so quickly; the challenges; and, in some cases, our sciences are not moving together in a way that is parallel. The vanishing zero that we have always talked about is now becoming even more apparent as CDC is reporting the finding of over 120 chemicals in human blood in their National Health and Nutrition Examination Survey—What do these chemicals do? What do they mean?

There are a lot of new challenges. The only prediction I can make with certainty is that there will be at least one major scientific challenge to be faced in the next couple of years that none of us can predict. That requires the ability to respond quickly, and to have the kind of training, background, and appreciation for science to be nimble in the face of bureaucratic obstacles.

Over the past 35 years, the Nation has benefited more from the research conducted by EPA than the American worker has benefited from research conducted by the National Institute of Occupational Safety and Health. I would argue that it is because they have not had people like you sitting with them as they go though the process. My best wishes to you in the future.

Question and Answer Session

How do we get the best balance of external and internal research while maintaining the effectiveness of EPA internal research, which has proven better than other models? Climate change is an example of an issue that is difficult for the Agency to work on alone, and may require universities or outside sponsored research support.

One approach is to find the best people inside and outside of the Agency. If they are outside of EPA, hire them or collaborate with them. There are plenty of good researchers out there developing good climate models, getting satellite data, and doing global climate models. Nobody else is doing adaptation and mitigation research, and that is a role that EPA can fill and do so credibly within its mission, which has a very important impact on what the other federal agencies are funding or doing within the climate change arena. It is those niches that EPA has to find and do its best work.

EPA has created a credible research program that works very well at bringing in outside researchers through the university systems and other sources, and this is probably the finest example that exists of an extramural research program in a mission agency. NRC did a remarkably positive and supportive report on the EPA extramural research program. EPA well understands how inter-institution and interagency collaboration works.

One of the important things can be done as an Agency and as researchers is to find our niche. For example, EPA began funding STAR grants on nanotechnology in 2001. As our awareness of the situation grows, we will fund an intramural research program. What is our niche? What are the holes that we can fill with our talents and abilities to get the most out of those talents and resources to make the biggest differences? There is a lot of talent inside and outside of the Agency.

Also, look at what the laws are and where the regulatory push is. EPA listed over 180 chemicals under the hazardous air pollutant provisions of the 1990 CAA Amendments. The impact of this was a decrease in the amount of hazardous air pollutant research done in the Agency. From the point of view of toxicology, it can be argued that there is no reason to decrease this research because there are still problems out there. Similar arguments come from the point of view of what interesting science still can be done. However, EPA appropriately decreased the research budget because it no longer met the criteria of "being important to know so that we can do something about regulating it."

The budget for EPA research has been the same since the mid-1980s. While incremental increases have occurred, how can the case be made that the order of magnitude of the EPA science budget is not right given the environmental challenges. How can the outside community help to make the case for better funding for EPA research?

Given the special EPA position as a regulatory agency with a research arm, the priorities will change over time. We have to identify those areas where EPA research will make the most difference; this means that research will move into new areas and leave more mature areas behind. EPA currently is in the process of setting priorities. Realistically, order of magnitude changes in funding are not likely to happen, so it is necessary to be more efficient and more effective in doing the science needed to be sure that we have the right information to make the decisions that have to be made.

This is also an opportunity to lobby. Other agencies have a constituency of scientists, engineers, and physicians that receive their funding and who are willing to act in response to proposed budget cuts. EPA does not have that kind of constituency because those who monitor EPA most closely are those who are regulated by EPA. The STAR fellowship program and grants program are, to a lesser extent, examples of establishing a constituency. When Congress tried to cut funding for the fellowship program, there was a lobbying campaign that was unprecedented, as far as EPA is concerned, and that fellowship program continued. EPA needs both a constituency and grassroots efforts to push Senators and Members of Congress to support EPA.

Where should EPA concentrate its efforts for future genomic research and technology? One area is analytical tools, but there may be others.

EPA put its program together through outreach, meetings, and workshops, which worked well. The vision that came out of that process was to develop tools and move towards a predictive paradigm to deal with unknowns as they arise, to be able to move back and forth between the experimental models and human systems, and to understand the molecular basis of comparability. This is right on the mark, it is meeting the test of other people in the field, and now is the time for implementation because it is a tool that can be used broadly on the ecological side as well as on the human health side. The way the plan was put together will stand the test of time, but needs to be nimble. Nanosensors are another emerging tool.

ORD research in the past focused on national research needs and, when those needs were met, ORD moved on. However, in the EPA Regions, research is still needed for implementing rules that have been generated on a national scale. The EPA Regions implement at a community level. What is the vision for meeting and augmenting the research needs for near-term decisions that EPA Regions need to make?

ORD has “customers” that need and want to use its science. There are regional science liaisons to work with the Office of Science Policy to work research needs into ORD. There also are national program directors providing points of contacts for agencies on specific research issues. There are many customers, and we try to be nimble, using STAR and other programs to address the issues. Region 1 is ORD’s lead region for next year, and discussions are underway to think about how to structurally address the issues involved and the way in which we interact. The social sciences are important when it comes to implementation and analysis of the way that the science actually ends up working. That is a challenge for the future—making sure that we have the expertise to help us all the way along the entire continuum from discovery in the laboratory to what is happening on the ground.

The Agency has continued to improve in doing this very difficult job, which goes in both directions. The EPA Regions have increasing commitments and so it can be difficult for the regional personnel to spend time thinking through the question “What are the crucial uncertainties that ORD research can address if I have to implement this,” as a new regulation is starting to develop. Trying to do this at the point of impending implementation is much more difficult. An important part of this is developing processes to enable the regional personnel to be able to think about what is coming down the road and to be able to work with ORD on what will be needed.

Closing Remarks

Dr. George Gray, Assistant Administrator of ORD, thanked the former Assistant Administrators for their service to the Agency and provided closing remarks to this session.

The experience and wisdom of this group and the work they have done has helped the scientific and research enterprises at EPA achieve the state that they have today. They have made it possible for ORD to be an organization that is populated with great people, organized to do great work, and is looking towards the future. Think about the many ways we have been successful as ORD and as an Agency. No river is going to catch on fire in the United States. The water, air, and land are cleaner.

EPA has made terrific strides, but the next series of challenges will require even more of our science and will involve trickier problems. Future challenges will require advanced science, new analytic tools and techniques, and high technology solutions. How do we think about the situation where we have life saving drugs that could also be having environmental impacts? How do we weigh those benefits to people and environmental effects? How do we think about what is important so that we can design better drugs and better processes? These are the kinds of questions we will face and there will not be any easy answers. Dealing with the climate, what kind of energy systems do we have? None of them are perfect. We need science to help us understand, weigh our alternatives, and make good choices.

Section VI: The Built Environment Plenary Session

Thursday, May 18, 2006

The purpose of this plenary session on the third day of the meeting was to explore trends in population demographics and associated impacts on transportation, land use, critical services, the built environment, and public health. An audience question and answer period and a poster-platform session followed the presentations.

Dr. Hal Zenick, with EPA, and Dr. Howard Frumkin, with NCEH and ATSDR, led this session on understanding how thoughtful planning of the built environment can eliminate or mitigate future environmental health problems. Presentations addressed the incorporation of environmental health in planning for land use, transportation, and critical services; the impact of the built environment on public health; and sustainable architecture and design at the National Building Museum.

The Built Environment

Dr. Hal Zenick (with EPA) and Dr. Howard Frumkin (with NCEH and ATSDR) led this session. Three speakers addressed smart growth planning concepts to reduce health impacts of population growth, the contribution of the built environment to human health, and principles of sustainable design.

EPA's Smart Growth Effort

Tim Torma, Acting Director of the EPA Office of Business and Community Innovation, discussed the incorporation of environmental health into planning land use, transportation, and critical services; obstacles encountered by communities; benefits of these planning efforts; and collaborative infrastructure planning efforts for developing healthy communities. The United States population is estimated to grow by over 60 million people between 2000 and 2025. This surge in population will result in an additional 24 million households. One-third of all presently developed land has been developed since 1976. By 2030, the Nation's developed land will increase by 50 percent. Growth patterns influence community goals, including public health, traffic congestion, air and water quality, and quality of life. We have to address how this growth will be accommodated.

Population trends, including a growing senior population and an increase in the number of single adults, have resulted in shrinking household sizes. For the first time, single adults outnumber couples with children as the most common type of household. Questions brought on by the changing demographics include: How will future growth patterns serve this growing population of elderly Americans? How will the growing elderly population affect driving?

To determine ways to accommodate the impending population growth, it is important to examine the distinct growth trends over the last 50 years:

- Employment and population growth heavily favored medium and large metropolitan regions over non-metropolitan areas

- Within metropolitan regions, most growth occurred in low-density development at the fringe of urbanized areas

- Emphasis on automobile travel to the exclusion of other modes.

The rate of population growth is part of the reason more land is being consumed, but how and where the growth is occurring are the primary drivers of development. According to the U.S. Department of Agriculture's National Resources Inventory, developed land in the United States increased 34 percent between 1982 and 1997. During the same 15-year period, the population grew by about 15 percent. Thus, land consumption occurred at more than twice the rate of population growth.

How and where growth occurs also can have big impacts on public health and the environment. The classic picture of sprawl includes strip commercial developments along highways and large lot residential subdivisions spreading out over farmland separated from employment centers, schools, and stores. More specific characteristics include:

- Random or unplanned growth characterized by inadequate accessibility to essential land uses, such as housing, jobs, and public services that include schools, parks, green space, and public transportation

- Land-consumptive development beyond the edge of service and employment areas

- Single use areas or zones that separate where people live from where they shop, work, recreate, and educate.

People are forced to use cars to get to the things they want and need to live. Sprawl is not new—it is an extension of long-established patterns of suburbanization, decentralization, and low-density development.

The EPA mission is to protect public health and the environment. How and where growth occurs can have big impacts on public health and the environment. Growth characteristics are multimedia, incremental, cumulative, very dispersed, and very large. These characteristics affect EPA's approach. Such growth and development patterns do not lend themselves to EPA's old approach.

Development will cause water quality, driving, air, land, and habitat impacts. Run-off from developed areas will cause water quality impairments in estuaries, rivers, lakes, and ocean shorelines. A 1-acre parking lot produces run-off volume almost 16 times larger than 1 acre of undeveloped meadow. Impervious surfaces lead to increased volume, velocity, and temperature of run-off; reduce groundwater recharge; and increase sedimentation and acidity. Mobile sources create 8.1 million tons of nitrogen oxides per year and 4.6 million tons of volatile organic compounds (VOCs) per year. Although cars are getting more efficient and cleaner, people continue to drive more; the increase in miles driven is not strictly driven by population growth. Habitat destruction is the main factor threatening 80 percent or more of the species listed under the Endangered Species Act.

EPA's strategy for working on development patterns is smart growth, which is development that revitalizes neighborhoods, protects farmland and open space, keeps housing affordable, and provides more transportation choices. There are numerous approaches to development that many successful communities have implemented. All of these strategies serve multiple objectives. For example, transit options can reduce air emissions and create a healthier community as more people walk to and from transit stops. The smart growth principles reflect the experience of localities that have successfully created smart growth communities, and are a way to help communities who want to make more informed decisions. These principles include:

- Mixing land uses
- Taking advantage of compact building design
- Creating a range of housing opportunities and choices
- Creating walkable neighborhoods
- Fostering distinctive, attractive communities with a strong sense of place
- Preserving open space, farmland, natural beauty, and critical environmental areas
- Strengthening and directing development towards existing communities
- Providing a variety of transportation choices
- Making development decisions predictable, fair, and cost-effective
- Encouraging community and stakeholder collaboration in development decisions.

Nothing specific causes growth. Growth is influenced by multiple factors, including the willingness of lending institutions to lend money for development, public opposition, and how and where our money is spent (e.g., police, schools, etc.). Growth is highly regulated, especially at the local level. Many communities mandate minimum lot size, number of parking spaces, and separation of businesses from residences.

EPA uses smart growth research to inform policy at federal, state, and local levels; influence the national conversation about development; and "level the playing field" between smart growth and conventional development. The current trend is not destiny. Development patterns over the next 50 years do not have to follow those of the last 50 years.

Indicator organisms are important because they can leave clues about the state of the ecosystem. Their decline may indicate a disturbance that alters the ecosystem. The best indicator of a healthy, livable environment is the pedestrian/bicyclist.

Human Health and the Built Environment

Dr. Howard Frumkin, Director of NCEH and ATSDR, discussed the impact of the built environment on human health, current and future health challenges, the contribution of the built environment, and progress on moving towards healthy places. CDC has adopted a series of Agency-wide goals to protect human health. One category in particular, healthy places, is pertinent to this meeting. Healthy places means healthy communities, homes, schools, travel, recreation, healthcare institutions, workplaces, and institutions.

The Nation's health issues must also be considered. Heart disease is the leading cause of death in the United States, accounting for nearly 30 percent of the deaths in 2002. Cancer accounts for one in five deaths. Few people get enough leisure time activity, and obesity is increasing in young people. There is no immediate sign of the obesity epidemic abating. Hypertension afflicts 40 percent of the men in the United States. A majority of us have at least one of the cardiovascular risk factors.

Disability must also be considered—What are the things that slow us down? These limitations have a big effect on our health. The two biggest causes of disability are heart disease and arthritis. Asthma prevalence is also affecting activity, as is depression; one in five Americans report having an incidence of major depression within the last year. We need to track our happiness. Even though there has been a dramatic increase in national income, we are not getting happier as a nation. This is a bigger contextual issue than mental health. We have to determine what will make us happy, as it does not appear to be the acquisition of material wealth. Happiness has more to do with interpersonal relationships—social relationships are key. Physical activity is directly related to the problem of heart disease. Contact with people and nature improves mental health.

It is important to examine the impending demographic shifts when trying to create healthy places. A greater diversity of people is expected, as is a growth in the 65 to 85 year old population. More than half of the elderly live in the suburbs. This will be important issue when we think about developing and building in cities. This also brings about a mobility issue—the elderly travel just about as much as the non-elderly. Petroleum will become scarce, which will have an impact on the way in which and why we travel.

Urban sprawl (low density use of land) has resulted in places being farther apart than ever before. This, in turn, has lead to longer trip distances and more time spent in the car. Urban sprawl has also contributed to the neglect of central city infrastructure. Good buildings and good utilities are being neglected and underused. Non-grid-like road designs are for traffic as opposed to pedestrians. Because schools are constructed far out from communities, children cannot walk or bike to school. Additionally, roads do not have sidewalks or they have sidewalks that are disintegrated or badly built. All of these factors impact human health. Not only have we become less physically active, but increased motor vehicle usage contributes to air pollution. Limited mobility affects the mental health of the elderly, as they do not have ready access to the resources that they need. Increased drive times contribute to road rage and anxiety, increase the likelihood of injury or death due to an automobile accident, and also leave less time for interaction with people.

The challenge to constructing healthy places is to design them to have room for more people, be accessible places for people of limited mobility (e.g., elders), and conserve scarce resources. Healthy places prevent illness and injury, promote physical activity, keep the air clean, permit convivial social interaction, and permit contact with nature. Solutions for smart growth may be public health principals as well. Design principles for public health include mixed land use, higher density areas balanced by green space preservation, transportation options (e.g., walking, biking, and transit), and construction of parks, public spaces, and affordable housing.

From a health point of view, not enough is known. The research in recent years is based on physical activity. There is a need for integrated assessments. We do know that environmental design matters. We need more consistent emphasis on health disparities and environmental justice. Positive built environment interventions may help, and could also have environmental and sustainability benefits as well.

There is legitimate disagreement as to where we stand. We need more research and must consider other factors as well, such as crime and schools. Crime and the desire for superior schools are major reasons why people move out of the cities. Behavioral changes must compliment the smart build. Positive messages need to be sent—community design is about healthy, wholesome places. Information needs to be made available to persuade people to make healthy choices. To find solutions, we need to think and collaborate broadly.

The Green House: New Directions in Sustainable Architecture and Design

Martin Moeller, Senior Vice President for Special Projects at the National Building Museum, provided an overview of the Green House exhibit, discussed the principals of sustainable design, and provided examples of green house design from around the world. The National Building Museum is a museum of the built environment with a focus not only architecture, but also on engineering. The purpose of the museum and its programs is to encourage the public to see and think about what they normally ignore, such as multi-lane highways. The public needs to know that they are empowered to influence green designs in their communities.

The National Building Museum was built as an office building, but has been a museum for the last 25 years. The Great Hall in the museum is a phenomenal space that has a number of interesting implications. The museum provides educational programs for all ages. The building itself is one of the earliest "green" buildings. It was a simple, yet elaborate design, to bring fresh air into the windows. It was designed to draw in warm air under the windows, which would then be heated and circulated throughout the building and vented in the center of the building.

The first green house exhibition at the National Building Museum dealt with large-scale structures that are going green (e.g., office buildings and airports). This illustrated that density is good and is an environmentally friendly development technique. On the topic of residential architecture, the key points that can be made are: aesthetic and green can go together, and informed decisions can be made to advance the green movement (e.g., consult with some one knowledgeable, or simply read the labels on household products such as paint).

There are five basic principles of sustainable design:

1. Optimizing use of the sun
2. Improving indoor air quality

3. Using the land responsibly
4. Creating high-performance and moisture-resistant buildings
5. Wisely using the Earth's natural resources.

Indoor air quality is a major part of green design to protect the health of people inside. The Green House exhibit in the museum includes a full-scale house called the Glide House. Every element of the house (furnishing, appliances, etc.) is annotated. The Glide House is prefabricated, and can be built for about $132 per square foot. The actual house in the museum uses a high velocity soft air ventilation system, forced air, and a wood slatted panel that can be moved around the house to control the wind and sun coming into the house.

Around the world, numerous green houses illustrate the range of options for this kind of construction. Design is part of the practice, and takes into account the fact that people are going to continue to want to live in suburban areas. Examples of houses from around the world illustrated key actions taken to promote sustainable design. These include making careful use of local materials, constructing pervious driveways (e.g., gravel), maximizing the use of natural light, using solar panels as an electricity source, taking a logical approach to landscaping, incorporating natural heating and cooling with geothermal pumps, using old industrial buildings as homes, and using salvageable materials found onsite.

Other ideas for sustainable design include the use of low VOC paints, natural clay plasters, and recycled materials. The level of public interest in green housing has grown. Most real revolutions in architecture and design have happened as a result of some other change. Sustainable design will be the defining factor in the design movement of the 21st century. The public has the power to demand that builders keep density high and use recycled and salvageable materials. Some of the upcoming projects at the National Building Museum include the Affordable Greening Symposium, the Green Renovation Symposium, and Green Communities (in 2009).

Questions and Answers

The speakers had an opportunity to address questions from the audience.

A brief question and answer period addressed a range of topics. These included: (1) an increase in telecommuting workers to decrease the number of annual miles driven, (2) the effect of the market on smart growth, (3) health surveys to determine if there are any adverse effects from high density areas, (4) the need to quantify health costs of sprawl, (5) the importance of local level efforts to push for smart growth, (6) involvement of mortgage lenders in green houses, and (7) the extent to which green design and green building are moving towards low income housing.

Poster-Platform Session

Dr. Laura Jackson (with EPA) and Dr. Drue Barrett (with CDC) chaired a poster-platform session elaborating on the three plenary topics:

- The EPA Smart Growth Effort

- New Directions in Sustainable Architecture and Design

- Human Health and the Build Environment.

Appendix A   Agenda

US EPA's Science Forum:
Your Health, Your Environment, Your Future

In cooperation with: the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Disease Registry (ATSDR), and the National Institute of Environmental Health Sciences (NIEHS)

The Forum will highlight the relationship between our environment and public health, and will include discussions on issues as diverse as the impacts of understanding the human genome and the impacts of the built environment. The Forum will also highlight the complementary roles of Federal public health agencies.

May 16-18, 2006
Ronald Reagan Building and International Trade Center
1300 Pennsylvania Avenue, NW
Washington, DC 20004
http://www.epa.gov/scienceforum

Tuesday, May 16, 2006

Plenary Sessions will take place in the Amphitheater on the Concourse Level

<table>
<tr><td>9:30 – 10:00 AM
Opening Plenary Session</td><td colspan="3">Welcome and Introductions – Dr. George Gray, Assistant Administrator, U.S. Environmental Protection Agency (EPA) / Office of Research and Development (ORD)

Perspectives on Environmental Public Health – Dr. James H. Johnson, Jr., Dean, College of Engineering, Architecture and Computer Sciences, Howard University</td></tr>
<tr><td>10:00 – 10:15 AM</td><td colspan="3">Break</td></tr>
<tr><td>10:15 – 10:30 AM</td><td colspan="3">EPA Commitment to Environmental Public Health – Marcus C. Peacock, Deputy Administrator of the U.S. Environmental Protection Agency</td></tr>
<tr><td>10:30 – 11:30 AM
Opening Keynote Plenary Session</td><td colspan="3">Opening Keynote Speaker
Secrets of the Human Genome – Dr. J. Craig Venter, Founder & President, J. Craig Venter Institute</td></tr>
<tr><td>11:30 AM – 12:30 PM</td><td colspan="3">Lunch on Your Own / Poster and Exhibit Viewing Opportunity</td></tr>
<tr><td>12:30 – 2:30 PM
Disease Susceptibility Plenary Session</td><td colspan="3">• The Genome and Disease Susceptibility – Dr. Steven Kleeberger, Chief of the Laboratory of Respiratory Biology, National Institute of Environmental Health Sciences (NIEHS)
• New Evidence in Life-Stage Susceptibility – Dr. Elaine Faustman, Professor, University of Washington
• Health Disparities – Dr. William H. Sanders, Acting Director, EPA / Office of Children's Health Protection and Environmental Education (OCHPEE)</td></tr>
<tr><td>2:30 – 3:00 PM</td><td colspan="3">Break / Poster and Exhibit Viewing Opportunity</td></tr>
<tr><td>3:00 – 5:00 PM
Disease Susceptibility Poster-Platform Sessions</td><td><u>Hemisphere B</u>

Poster-Platform Session 1
The Genome and Disease Susceptibility</td><td><u>Hemisphere A</u>

Poster-Platform Session 2
New Evidence in Life-Stage Susceptibility</td><td><u>Oceanic AB</u>

Poster-Platform Session 3
Health Disparities</td></tr>
<tr><td>5:00 – 7:00 PM</td><td colspan="3">Poster Viewing Session and Poster Awards Reception (<u>Atrium Hall</u>)
Join us for an exciting networking opportunity and showcase of excellence in science! During this session you will have an opportunity to meet with your peers and explore the science they are presenting at this year's Forum while we recognize award-winning science posters.</td></tr>
</table>

Detailed Agenda for Tuesday, May 16th

Forum Opening (9:30 – 11:30 AM)

Welcome, Meeting Information and Introductions – **Dr. George Gray**, Assistant Administrator, EPA Office of Research and Development

Perspectives on Environmental Public Health – **Dr. James Johnson**, Dean, College of Engineering, Architecture and Computer Sciences, Howard University

EPA Commitment to Environmental Public Health – **Marcus C. Peacock**, Deputy Administrator of the U.S. Environmental Protection Agency

Opening Keynote Speaker
"Secrets of the Human Genome" – **Dr. J. Craig Venter**

> This opening presentation will feature one of the leading scientists of the 21st century and his visionary thoughts on genomic research and the intersection between genomics and environmental and energy policy. The presentation will highlight current efforts in advancing the science of genomics and in applying genomic advances to some of the world's most vexing public health and environmental challenges.

Plenary Session: Disease Susceptibility and the Environment (12:30 – 2:30 PM)

Session Co-Chairs: Dr. Julian Preston (EPA) and Dr. William Suk (NIEHS)

Disease Susceptibility and the Environment chronicles progress in understanding why some of us succumb to illness while others remain well. Session topics include:

1. **The Genome and Disease Susceptibility** explores: 1) the innovative work related to the genome and human disease susceptibility, and 2) the relevance of this new science to public health risk assessment, as well as recent advances in genomics/proteomics/metabonomics.

   Speaker: **Dr. Steven Kleeberger**, Chief of the Laboratory of Respiratory Biology, NIEHS

2. **New Evidence in Life-Stage Susceptibility** explores: 1) the susceptibilities of children and how childhood environmental exposures may lead to health problems throughout life, and 2) discoveries that have brought to light both how resilient the aging population really is, and yet, why they sometimes have special vulnerabilities to environmental pollutants.

   Speaker: **Dr. Elaine Faustman**, Professor, University of Washington

3. **Health Disparities** delves into the ways in which poverty and cultural differences can shape our lifestyles and attendant exposures to produce differential environmental health impacts. Research results and new challenges related to environmental equity issues will be explored.

   Speaker: **Dr. William H. Sanders**, Acting Director, EPA/OCHPEE

Poster-Platform Sessions: Disease Susceptibility and the Environment (3:00 – 5:00 PM)

Poster Session Chairs: Dr. Andrew Geller (EPA), Dr. Bruce Fowler (ATSDR), Dr. Julian Preston (EPA) and Dr. William Suk (NIEHS)

Three concurrent poster-platform sessions follow the *"Disease Susceptibility and the Environment"* plenary session. These poster-platform sessions correspond to and elaborate on the three subjects highlighted by plenary session talks: *1) The Genome and Disease Susceptibility; 2) New Evidence in Life-Stage Susceptibility; and 3) Health Disparities.* Six to eight selected posters per poster-platform session will be presented by the primary investigators. Open group discussion follows. Additional related posters will be displayed in the Atrium Hall.

Wednesday, May 17, 2006

Plenary Sessions will take place in the Amphitheater on the Concourse Level

<table>
<tr><td>8:30 – 10:30 AM
Global Challenges Plenary Session</td><td colspan="4">• Changing Environments – Dr. Rita Colwell, Senior Advisor and Honorary Chairman of Canon U.S. Life Sciences
• Changing Diseases – Dr. Henry Falk, Director, Coordinating Center for Environmental Health and Injury Prevention, Centers for Disease Control and Prevention (CDC)
• Changing Assessments – Dr. Peter Preuss, Director, EPA / ORD / National Center for Environmental Assessment (NCEA)
• Changing Responses – Dr. Michael Shapiro, Deputy Assistant Administrator, EPA / Office of Water (OW)</td></tr>
<tr><td>10:30 – 11:00 AM</td><td colspan="4">Break / Poster and Exhibit Viewing Opportunity</td></tr>
<tr><td>11:00 AM – 12:00 PM</td><td colspan="4">Former EPA Assistant Administrators for Research and Development (<u>Amphitheater</u>)
In recognition of EPA's 35th Anniversary Celebration, Dr. George Gray and six former Assistant Administrators for ORD will come together to participate in a discussion about the current and future science challenges facing EPA.</td></tr>
<tr><td>12:00 – 1:00 PM</td><td colspan="4">Lunch on Your Own / Poster and Exhibit Viewing Opportunity</td></tr>
<tr><td>1:00 – 3:00 PM
Global Challenges Poster-Platform Sessions</td><td><u>Continental C</u>

Poster-Platform Session 1
Changing Environments</td><td><u>Oceanic AB</u>

Poster-Platform Session 2
Changing Diseases</td><td><u>Hemisphere A</u>

Poster-Platform Session 3
Changing Assessments</td><td><u>Hemisphere B</u>

Poster-Platform Session 4
Changing Responses</td></tr>
<tr><td>3:00 – 3:30 PM</td><td colspan="4">Break / Poster and Exhibit Viewing Opportunity</td></tr>
<tr><td>3:30 – 5:30 PM
Special Program Sessions</td><td><u>Atrium Hall / Amphitheater / Woodrow Wilson Plaza</u>
Poster and Exhibit Viewing Opportunity</td><td><u>Oceanic AB</u>

Special Program
Federal Technology Transfer Act Training</td><td><u>Hemisphere A</u>

Special Program
Innovations in Risk Assessment Practice</td><td><u>Hemisphere B</u>

Special Program
Emerging Leaders Network</td></tr>
</table>

Plenary Session: Global Challenges (8:30 – 10:30 AM)

Session Co-Chairs: Dr. Anne Grambsch (EPA) and Dr. Chris Portier (NIEHS)

Global Challenges looks at how a changing environment is giving rise to potential new public health risks, and actions that could be taken to ameliorate these risks. Session topics include:

1. **Changing Environments** explores new public health challenges that are arising as global stressors change. Diseases that have emerged or re-emerged in recent years are the result, in part, of factors such as human behavior, global transportation patterns, extreme weather events and other changing environmental conditions. This session examines these environmental stressors and the implications for human disease. Biocomplexity, as well as changes in ecosystems and habitats that impact disease risks and quality of life, will also be discussed.

Speaker: **Dr. Rita Colwell**, Distinguished University Professor, University of Maryland at College Park and Johns Hopkins University Bloomberg School of Public Health, and Senior Advisor and Honorary Chairman of Canon U.S. Life Sciences

2. **Changing Diseases** explores threats to public health that are changing in response to a changing environment, e.g., changing human behavior, global transportation patterns, extreme weather events. This session examines the changing picture of environmental public health and delves into how new research and technologies can be used to track and guide efforts to address these public health threats.

   Speaker: **Dr. Henry Falk**, Director, Coordinating Center for Environmental Health and Injury Prevention, CDC

3. **Changing Assessments** considers what we have learned about human health risks, how those risks are currently evaluated, and what changes need to be made to move risk assessment into the future. State-of-the-art approaches to health risk assessment and emerging challenges will be explored.

   Speaker: **Dr. Peter Preuss**, Director, EPA/ORD/NCEA

4. **Changing Responses** explores how US federal health agencies have worked together to achieve remarkable success reducing US risks related to air and water pollution, which are listed among the 10 greatest hazards to public health by the World Health Organization. The session also examines how international agencies, US federal health agencies, and state and local health departments are working to meet new challenges to environmental public health. Cooperative interactions among governmental bodies and organizations to clean up and protect the environment and public health will be highlighted.

   Speaker: **Dr. Michael Shapiro**, Deputy Assistant Administrator, EPA/OW

Poster-Platform Sessions: Global Challenges (1:00 – 3:00 PM)

Poster Session Chairs: Dr. Mike Slimak (EPA), David Bussard (EPA), Dr. Andrew Geller (EPA), Dr. Bruce Fowler (ATSDR) and Dr. Chris Portier (NIEHS)

Four concurrent poster-platform sessions follow the *"Global Challenges"* plenary session. These poster-platform sessions correspond to and elaborate on the four subjects highlighted by plenary session talks*: 1) Changing Environment; 2) Changing Diseases; 3) Changing Assessments; and 4) Changing Responses.* Six to eight selected posters per poster-platform session will be presented by the primary investigators. Open group discussion follows. Additional related posters will be displayed in the Atrium Hall.

Special Program Sessions (3:30 – 5:30 PM)

Federal Technology Transfer Act Training (CRADAs)

Cooperative Research and Development Agreements (CRADAs) are the primary mechanism for establishing partnerships between federal laboratories and other research partners - including non-federal partners - to exchange personnel, equipment, services, and expertise for a specific research project. Under the authority of the Federal Technology Act of 1986, these partnerships are intended to provide a more efficient and effective means by which to apply federally funded technology to use in real-world applications.

Innovations in Risk Assessment Practice

"Innovations in Risk Assessment Practice" will highlight novel approaches to address challenges in assessing human health risk. Specific examples will illustrate emerging approaches for estimating risks from low or acute exposures, for applying toxicogenomic data and life stage information, and for

assessing human exposures. In addition, considerations for characterizing uncertainty and assessing cumulative risk will be explored.

Session Chair: Dr. John Vandenberg, EPA

Emerging Leaders Network

The EPA Emerging Leaders Network (ELN) aims to provide networking and professional development opportunities for new, young (and young at heart) professionals at EPA. The Emerging Leaders Network is designed to offer a friendly, informal, yet structured environment for young Agency professionals to meet, network, learn about ongoing and emerging activities across the Agency and support each other in a collegial and collaborative atmosphere. The ELN includes fellows, interns, new graduates and new hires with a variety of scientific and technical backgrounds. The 2006 EPA Science Forum Emerging Leaders Network session will include a panel discussion on sustainability, stewardship, and collaborative programs.

Poster and Exhibit Viewing Opportunities

Posters: Located in the Atrium Hall, Concourse Level

Indoor Exhibits: Located in the Amphitheater Foyer, Concourse Level

Outdoor Exhibits: Located on the Woodrow Wilson Plaza, Ground Level (**May 16-17 only**)

Thursday, May 18, 2006

Plenary Sessions will take place in the Amphitheater on the Concourse Level

8:30 – 10:30 AM The Built Environment Plenary Session	• EPA's Smart Growth Effort – **Tim Torma**, Deputy Director, EPA / Office of Business and Community Innovation (OBCI) • The Green House: New Directions in Sustainable Architecture and Design – **Martin Moeller**, Senior Vice President for Special Projects, the National Building Museum • Human Health and the Built Environment – **Dr. Howard Frumkin**, Director, CDC's National Center for Environmental Health (NCEH) and Agency for Toxic Substances and Disease Registry (ATSDR)
10:30 – 11:00 AM	Break / Poster and Exhibit Viewing Opportunity
11:00 AM – 1:00 PM The Built Environment Poster-Platform Session	Session: Amphitheater / Posters: Oceanic AB *Poster-Platform Session* The Built Environment

Plenary Session: The Built Environment (8:30 – 10:30 AM)

Session Co-Chairs: Dr. Hal Zenick (EPA) and Dr. Howard Frumkin (NCEH and ATSDR)

The Built Environment looks at demographic trends and how thoughtful planning of our built environment can eliminate or mitigate future environmental health problems. Certain organizations have been at the leading edge in planning our built environment. This session explores what solutions we have found, what we have learned and how we can better envision future problems and solutions.

1. **EPA' s Smart Growth Effort** has been forward thinking in the incorporation of environmental health in planning land use, transportation and critical services planning, examining obstacles

encountered by communities, and analyzing the benefits of these planning efforts. This session will focus on collaborative infrastructure planning efforts in developing healthy communities, including: recent research that challenges conventional wisdom about land use and the environment, and new approaches to urban and regional planning. New innovations to meet the evolving demands of the future will be highlighted.

Speaker: **Tim Torma**, Deputy Director, EPA/OBCI

2. **The Green House**: **New Directions in Sustainable Architecture and Design**, an exhibition at the National Building Museum, examines new developments in green technology and products; explores the building materials, consumer products, and energy systems that offer attractive and often affordable sources of the latest in home building technology and products; delves into developments in sustainability; and provides an informative overview of this dynamic design movement.

   Speaker: **Martin Moeller**, Senior Vice President for Special Projects, National Building Museum

3. **Human Health and the Built Environment** explores trends in population demographics and the anticipated impacts on transportation, planning land use and critical services needs. With new science and new methods we can predict our future as never before and position ourselves to shape that future. The focus will be on trends and the demands placed on the environment and public health.

   Speaker: **Dr. Howard Frumkin**, Director of NCEH and ATSDR

Poster-Platform Session: The Built Environment (11:00 AM – 1:00 PM)

Poster Session Chairs: Dr. Laura Jackson (EPA) and Dr. Drue Barrett (CDC)

A poster-platform session will follow the *"Built Environment"* plenary session and will correspond to and elaborate on the three subjects highlighted by plenary session talks*: 1) EPA's Smart Growth Effort; 2) The Green House: New Directions in Sustainable Architecture and Design; and 3) Human Health and the Built Environment.* Six to eight selected posters will be presented by the primary investigators. Open group discussion follows. Additional related posters will be displayed in the Atrium Hall.